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# Science & Technology

China

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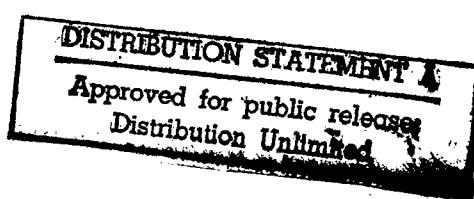
JPRS-CST-89-008

29 MARCH 1989

SCIENCE & TECHNOLOGY

CHINA

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Technology Reform Said Key to Enterprise Survival

40080092 Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENCE OF SCIENCE AND MANAGEMENT OF S&T] in Chinese No 10, Oct 88 p 1

[Article by Zhang Xiangyan [1728 4161 1484], State Scientific and Technological Commission Information Center]

[Text] The key to the technological progress of China's large and medium-sized enterprises in the present phase is technology reform.

Industrial and business technological activities, from the perspective of getting started, are composed primarily of technological reform, technology importation and its assimilation and absorbtion, and technology development activities.

"Technology reform activities" refers to an enterprise applying scientific and technological achievements to each area of business production (products, facilities, technologies, etc.) based on the prerequisite of upholding scientific and technological progress in order to realize expanded reproduction centered on intrinsic factors. In this way, product quality can be improved, replacement of older generations with newer ones can be promoted, energy can be saved, costs can be reduced and activities of society-wide economic benefit can be enhanced overall.

The components of technology reform carried out by the enterprises themselves to internally improve technological competence and economic returns should fall within the category of technology development, while technology introduction itself and that which is mutually involved with it, excepting the assimilation, absorbtion components which are functions of technology development, take technology reform as the primary objective.

According to China's conventional method of managing technology, in large and medium-sized enterprises technology reform is the principal part of technology activities. In the 1986 Nationwide General Survey of Science and Technology, 6,493 large and medium-sized enterprises across the country were investigated. Of overall technology expenditures, technology reform accounted for 58.6 percent, technology development accounted for 21.8 percent and technology importation accounted for 19.2 percent, while purchase of domestic technology only accounted for 0.4 percent.

At present China's large and medium-sized enterprises, especially those key enterprises established before the founding of the country and during the "First Five-Year Plan" generally are contending with equipment obsolescence, dilapidated factory buildings, backward technology and inadequate production stamina. The implementation of technology reform is urgently required.

Based on a 1987 survey by relevant departments of over 500 large and medium-sized key enterprises, it was discovered that these key enterprises had relatively high wear and tear on fixed assets with fixed asset net worth only 61.8 percent of original value. This is lower than the 66.8 percent average level of fixed asset net worth during the same period of enterprises under the public ownership system. There were over 30 enterprises which did not even reach 40 percent. At the same time, the major production equipment of these 500-plus enterprises was backward. According to standards stipulated by the General Survey of Industry, only 12.7 percent of these enterprises possessed international-class equipment, 19 percent possessed equipment of an advanced domestic level, while the equipment of 47.9 percent was of general domestic level. As of the end of 1987, 20.4 percent fell within the backward domestic level. The latter two categories account for a total of 68.3 percent.

It is apparent that large and medium-sized enterprises must make a major effort to carry out technology reform.

The primary technology reform problem facing large and medium-sized enterprises in the present stage concerns sources of funding.

As far as sources of fixed asset investment are concerned, during the "Seventh Five-Year Plan" reliance was, for the most part, on independent fund raising by the enterprises and on bank loans. These two sources accounted for 78.2 percent (the remainder were funds allocated in the national budget and foreign investment). However, there are difficulties in implementing these two components of funding. First, independently held funding is inadequate. Although over these past few years the retained profits of the enterprises have increased, their burden has also become heavier. Therefore, exclusively relying upon depreciation and production in developing funding still leaves a significant shortfall. Second, bank loans are not practicable. Not only is the interest rate high (1 to 3 percent higher than the interest rate on capital construction loans), making borrowing unaffordable, but also the banks are unwilling to make loans for low-profit projects.

In order to support technology reform in enterprises, it is my opinion that the State should adopt policies advantageous to large and medium-sized key enterprises. For example, increasing the rate of depreciation, returning depreciation funds accumulated by original industries and localities to the enterprises and exemption from funding of major energy and transportation construction. Regulatory taxes should be reduced and encouragement provided for the use of these funds in technology reform.

Enterprises should be given decision-making power over the introduction of foreign technology and foreign management, so as to make them genuinely competitive in international markets and so that reform and progress can be obtained.

Large and medium-sized key enterprises definitely must probe into which model of technology reform has the features and environmental prerequisites best suited to themselves. Today, the primary models are as follows: 1) Take product modernization as the central link, organize superior S&T capability and strictly follow the scientific process in carrying out technology reform of enterprises. 2) Fully exploit the technological strong points and equipment potential of the old enterprises and follow the path of electro-mechanical integration. The approach of fully utilizing old, outmoded, equipment; accurately analyzing its value and applied value and making broad use of micro-electronic technology in upgrading this technology has been summarized by Comrade Zhao Ziyang as "adding computer control to old equipment" and has received his full approval. 3) Simultaneous with regeneration through independent effort and bold advancement of new ideas attention is paid to the introduction of advanced foreign equipment and technology, and assimilation and absorbtion are accomplished. In taking this route particular attention should be paid to correct handling of the relationship between introduction of foreign technology and equipment, and the adoption of advanced domestic technology and equipment. The existing foundation should be utilized as far as possible, with only small amounts of key technology imported, so as to improve the return on investment in technology reform, creating a greater yield from limited funds.

Lanzhou Heavy Ion Accelerator Complete

40080104a Beijing BEIJING KEJI BAO in Chinese 30 Nov 88 p 3

[Text] Heavy ion physics is a new branch of nuclear physics initiated in the 1960's. It is an interdisciplinary science in which high speed heavy ions are used in the bombardment and subsequent investigation of the internal structures of nucleus, atoms, molecules, various condensed matters and even biological materials. Due to the large mass and charge of heavy ions, accelerated heavy ions are much more effective than light ions in bombarding the nucleus and "opening up" new realms of study. Heavy ion physics has become one of the major leading frontier topics in atomic physics.

A majority of research efforts in atomic physics today are concentrated in the area of heavy ion physics. Major breakthroughs have been made in the study of heavy ion and nucleus interaction mechanisms, in the synthesis of new elements and nuclei, and in the investigation of properties of nuclear structures and materials. In the meantime, the importance of applying heavy ion beams to the national economy, defense, and other technical areas is also beginning to be recognized. Developments in heavy ion physics has attracted the attention of governments and scientists in many countries. Since the late 1960's, many new heavy ion accelerators have been built and old accelerators modified to facilitate further developments in heavy ion physics.

The Lanzhou heavy ion accelerator is China's largest heavy ion accelerator and is an important facility for frontier investigations in nuclear physics. It consists of a two-stage system of a main accelerator and an injection accelerator. It has a front and a back beam transport line and eight experimental terminals. When the accelerators are operated in tandum, carbon ions may be accelerated to an energy of 100 MeV/A, and xenon ions may be accelerated to 4.8 MeV/A. The injection accelerator may also be operated separately for ions from carbon to xenon to energies of 100 MeV and 60 MeV respectively, or for accelerating light ions of P, D, and a. The plan is to build 16 beams and 19 target stations in the experimental area. Eight experimental terminals will be built first. They are on-line isotope separator, large area position sensitive ionization chamber, heavy ion telescope

with time-of-flight measurement, in-beam γ detection, 2.5-3 meter diameter spherical general purpose target chamber, isotope target chamber, helium nozzle transport separator, and heavy ion illumination apparatus. Other experimental stations will be built later.

The Lanzhou heavy ion accelerator is a multidisciplinary facility. It can be used for the acceleration of a variety of heavy ions to reveal further information about the structure and motion of atomic nuclei. It can also be used in the synthesis of different new isotopes, some of these will have practical values to the national economy. Moreover, ion beams of different species and energy from this accelerator will be used in the research of material science, life science, and medicine. For example, ion implantation or illumination with different species of ions at different energies may be used in the modification of surface and bulk properties, chemical composition and structure of materials and in the search for new materials. Heavy ion radiation damage, including simulated fast neutron damage of materials, is important to high tech development in space and nuclear power plants. Microprocessing with heavy ions such as perforation, photoetching and so on may become a powerful tool in the development of VLSI. In biomedical applications, since heavy ions have a finite range and a high value of linear energy transfer, and release a great amount of energy at the end of their range, they may be used in the study of dosimetry, radiation biology, and biological effects in animal experiments.

State Licences Pesticides Producers

40101012 Beijing CHINA DAILY (BUSINESS WEEKLY) in English 20 Feb 89 p 2

[Article by staff reporter Zhang Yuan]

[Text] Anyone producing pesticides must obtain a licence under State Council regulations that went into effect on 1 February.

The Ministry of Chemical Industry is in charge of granting these licences. After getting the production licences, enterprises producing pesticides should apply for business licences from the departments of the Industrial and Commercial Administration, ECONOMIC DAILY reported.

According to the State Council, effective 1 March all enterprises without proper licences must stop pesticide production.

The country started to monopolize the selling of pesticides the first of this year in a move to guard the interest of farmers. Some farmers suffered severe financial losses last year when they purchased fake pesticides.

According to the CHINESE CONSUMERS JOURNAL, between January and September last year, pesticide examination stations in Anhui, Shanxi, Shandong, Hunan provinces and Guangxi Zhuang Autonomous Region checked 2,082 pesticides, finding that 670 contained no pesticides at all and 1,077 failed to reach State standards. These fake and low-grade products made up 84 percent of the total examined pesticides.

In Jintan County alone in Jiangsu Province, there were 150 factories making fake pesticides.

The paper said fake pesticides caused farmers great economic losses. For instance, about 8,000 mu (about 533 hectares) of cotton in Shandong were almost completely damaged by fake pesticides. In Runan County, Henan Province, about 100 hectares of rice were dead six days after farmers used fake pesticides.

To support the State policy that the country should have a good harvest this year, the Ministry of Chemical Industry plans to produce 200,000 tons of pesticides, 33,000 tons more than last year.

Besides increasing domestic production, Minister Qin Zhongda said it also will import some pesticides, mainly for use in pesticide production.

The country has 190 enterprises, with 90,000 employees, involved in producing pesticides.

In the past 10 years, the industry has produced 4.08 million tons of pesticides and contributed much to the country's agriculture.

According to the CHINA CHEMICAL INDUSTRY NEWS, in the last 10 years, the use of pesticides helped the country cut losses.

Thanks to the use of pesticide, the country each year gets an extra harvest of about 22.5 billion kilograms of grains, 6 percent of the country's total annual grain yield and 400 million kilograms of cotton, about 10 percent of its annual total.

Pesticides helped farmers to get an extra yield of 28 billion kilograms of vegetables and 3.3 billion kilograms of fruits each year, about 20 percent of annual production.

Pesticide has become an important material to help agricultural production increase, the CHINA CHEMICAL INDUSTRY NEWS said.

Insecticides and mite and weed killers are in great demand and production of these pesticides should be increased, the paper said.

New Design Method for Tracking Controller and Its Application

[English abstract of article by Yang Di [2799 3321], Feng Wenjian [7458 2429 0494], and Wu Yaohua [0702 3852 5478] of the Flight Dynamics Teaching and Research Section]

[Text] A new design method for a model-tracking controller is presented. Using this method, the output of a linear time-invariable system can accurately track the output of a reference model system. The controller designed by this method consists of the feedforward of the reference model system state (or estimated state) and the feedback of the controlled plant state (or estimated state). Computations of feedback and feedforward gain are simple and the design procedure is highly systematized. Satisfactory results in the design of a BTT [bank-to-turn] missile autopilot are obtained by using this method. Key words: Model output tracking; Linear time-invariable plant; Reference model system; Kalman filter; State observer; BTT missile autopilot.

References:

[1] Fitts, J.M., "Aided Tracking as Applied to High-Accuracy Pointing System," IEEE Trans. on Aerospace and Electronics Systems, Vol 9, May 1973.
[2] Anderson, B.D.O. and Moore, J.B., "Linear Optimal Control," Prentice-Hall Inc., New Jersey, 1971.
[3] Kwakerneak, K. and Siven, R., "Linear Optimal Control Systems," Wiley-Interscience, New York, 1972.
[4] Kreindler, E. and Rothschild, "Model-Following in Linear Quadratic Optimization," AIAA Journal, Vol 14, July 1976.
[5] Tiroshi, I. and Elliott, J.R., "Explicit Model-Following Control Scheme Incorporating Integral Feedback," Journal of Aircraft, Vol 11, June 1974.
[6] Bradshaw, A. and Porter, B., "Design of Linear Multivariable Continuous-Time Tracking Systems Incorporating Feedforward and Feedback Controllers," Int. Journal of System Science, 1975, Vol 6, No 5.
[7] Jie Xueshu [6043 1331 2579], "Optimal Control Theory and Application," Qinghua University Publishers, 1986.

Status, Developmental Trends of Electronic Materials

[Article by Chief Engineer and Senior Engineer Song Bingzhi [1345 4426 3112] and Laboratory Director and Senior Engineer Shen Nengjue [3088 5174 3778] of the Tianjin Electronic Materials Institute, Ministry of Electronics]

[Text] Abstract: The field of electronic materials evolved in responding to the needs of electronic technology and is the basis for developing electronic science and industry. It is characterized by the wide range of materials (more than 25,000), the small amount of material used and the high technical requirements (high purity, homogeneity, and integrity). It touches upon metallurgy, chemical engineering, textile, and construction materials. In recent years, under the strong support of the state and the various materials departments, production and research of electronic materials has made considerable progress; but it is still a long way from satisfying the needs in the electronic industry and from advanced international standards. Generally speaking, the current level of electronic materials in China is about equivalent to the international standards of the late 1960's and early 1970's.

Semiconductor Materials

Semiconductor materials occupy an important position in electronic materials and the most important material today is silicon because more than 90 percent of semiconductor devices are made with single crystal silicon. The preparation of single crystal silicon is done mainly with the vertical pulling method (the CZ [i.e., Czochralski] method), the float-zone (FZ) method and the neutron transmutation method. Silicon research abroad has been centered on ways to achieve higher purity and better electrical and physical homogeneity and structural integrity. Current interests are mainly concentrated on nonmetallic impurities such as oxygen and carbon. Single crystals grown by pulling usually have carbon impurities in the 1×10^{16} to 1×10^{17} cm^{-3} range and single crystals grown by zone refining are estimated to have a carbon content of 5×10^{15} to 1×10^{16} cm^{-3}. The oxygen content is generally 18-40 ppm (24-33 ppm for batch production) and the homogeneity of oxygen content in high-quality materials can usually be controlled to within 10 percent. In terms of product integrity, foreign silicon single crystals

have long since achieved a dislocation-free state and zone-refined crystals are mostly free from vortex defects. China had a relatively early start in silicon research; the first single-crystal silicon was grown in 1958 and the first dislocation-free silicon single crystal in 1962. Today the output of single crystals is about 60-70 tons per year. In the Seventh 5-Year Plan, mainly 3-4-inch-diameter silicon wafers were used. Estimates show that in the 1990's the main item [in use] will be 5-6-inch-diameter wafers, with 8-inch-diameter wafers being developed in the 1990's. In terms of research, extensive studies of microdefects and the behaviors of oxygen and carbon in silicon began in the mid-1970's. In addition, in-depth investigations of thermally induced donors, new donors, and the sedimentation dynamics of oxygen in silicon were also made. In terms of crystal growth technology, reduced pressure pulling and neutron transmutation doping have been widely studied. Zone-melting single-crystal nitrogen doping was successfully developed to improve the mechanical strength of silicon wafers. Also underway are pulling in an external magnetic field and pulling with continuous feeding.

Semiconductor compounds have unique physical properties and occupy an important position in microwave IC's, opto-electronic IC's, and very-high-speed integrated circuits (VHSIC's). Among the semiconductor compounds, GaAs [gallium arsenide] is the most studied and has the broadest applications. GaAs single crystals made in China and abroad can generally be divided into two categories: high resistance (semi-insulating) and low resistance (n type and p type). Methods of growth are generally the horizontal Bridgeman method and the liquid-seal vertical pulling method. In order to satisfy the requirements for developing VHSIC's, the high-pressure in-situ synthetic liquid-sealed vertical pulling method was also developed in recent years. Semi-insulating GaAs is a key material in VHSIC's and it has long been available commercially in foreign countries. Single crystals are mostly 50 mm in diameter, but larger ones have also been developed. China can now reproducibly grow 50-75-mm-diameter, 1-kilogram (to a maximum of 3 kg) high-quality undoped semi-insulating single crystals. By controlling the chemical stoichiometry and pulling conditions, the resistivity of the crystal is greater than 10^8 $\Omega \cdot$cm, the mobility is about 6000 to 7000 $cm^2/V \cdot$s, and the dislocation density is 10^2 to 10^4 cm^{-2}. Re-doping of low-resistivity GaAs is aimed mainly at lowering the dislocation density, improving the homogeneity and reducing the cost.

The importance of InP [indium phosphide] is second only to GaAs; it is mainly used in the fabrication of microwave and millimeter-wave devices and long-wavelength opto-electronic devices. It is usually grown with the high-pressure liquid-seal vertical pulling method. InP crystals were first successfully grown abroad in 1968 and today 50-mm-diameter samples are available commercially. The largest InP crystals are 80 mm in diameter and weigh about 3 kilograms. China began work on InP in 1975 and can now grow 25-40-mm-diameter, 500-1000-gram single crystals. In recent years new doping techniques have allowed considerable improvements in crystal integrity, and the dislocation density has been lowered to 2×10^4 - 3×10^4 cm^{-2}. Most recently, low-S-doped, low-dislocation-density (<100 cm^{-2}) single-crystal InP with a wafer area greater than 5 cm^2 has also been developed. The

emphases in InP research will be integrity, semi-insulation, shallow- and deep-energy-level impurities, and the study of physical and chemical properties.

Other III-V compounds such as GaP, GaN, InSb, and ternary and quaternary solid solutions GaAsP, GaAlAs, GaInAs, and GaInAsP have all been used in microwave and optoelectronic devices and some have reached the application stage.

II-VI and IV-VI-family compound semiconductors are important sensor materials. Applications have been found for CdTe, HgCdTe, PbTe, and PbSnTe.

Two new technologies in semiconductor fabrication should be mentioned. These are the metallo-organic chemical vapor deposition (MOCVD) method and the molecular beam epitaxy (MBE) method. These methods have had rapid development in recent years and have showed vast superiority in device fabrication. Using these new material-processing techniques, new devices such as the superlattice device, the high-electron-mobility transistor (HEMT) and the quantum-well laser have been developed and some of them put into practice.

Future trends in semiconductor research can be summarized as follows: 1) Further improvement in the quality of silicon single crystals, and further development of compound semiconductor materials, of research on fabrication of ultrathin films, of basic research on the superlattice, and of VHSIC's; 2) beginning research on new opto-electronic materials; 3) speeding up the study of semiconductor sensors; and 4) improving the nuclear hardening of semiconductor materials and investigation of new materials.

Magnetic Materials

Magnetic materials are crucial to electronic technology and the consumption is high. In recent years, while performance is being improved, development is toward single-crystal, thin-film and amorphous materials.

Permanent magnetic materials account for a large fraction of magnetic materials. It is estimated that the consumption ratio of permanent magnets and soft magnets is 2:1. Today alnico and ferrite permanent magnets are produced the most and widely used. New rare-earth permanent magnets and iron-chromium-cobalt machinable magnets also form their own systems. Alnico is one of the most important permanent magnetic materials. While no breakthroughs have been made in the past 10 years, China has reached the international standard in alnico research. The output in 1984-1985 was estimated to be 2,500 to 3,000 tons. Development standards are listed in Table 1.

Ferrites are the most widely used permanent magnets. The main varieties are barium ferrite ($BaFe_{12}O_{19}$) and strontium ferrite ($SrFe_{12}O_{19}$).

Table 1. Status of Research on Three Typical Alnico Permanent Magnet Alloys

Material	Composition (wt%)	$H_c(Oe)$	BH(MGOe)	$B_r(kG)$
High-residual-magnetism alloy (granular)	Generally no Ti, 24 Co. Sometimes need to add trace amounts of Si, Ti and Nb	700 to 840	7.5 to 8.5	13.0 to 14.5
High-magnetic-energy alloy (rod-like granular)	4.5-6.0 Ti, 34-35 Co, may require adjusting contents or trace amounts of Si and Nb	1400 to 1600	11.0 to 13.0	11.0 to 11.5
High-coercivity and high-magnetic-energy alloy (rod-like grains)	High Ti (7-8), high Co (38-40), may require trace amounts of Si and Nb	1800 to 2100	10.0 to 11.7	8.9 to 10.0

Rare-earth permanent magnets hold considerable promise. The first-generation rare-earth magnets are RCo_5 materials, and the second-generation rare-earth permanent magnets R_2Co_{17} were developed in the mid-1970's. China started studying rare-earth cobalt permanent magnets in the early 1970's and began research on second-generation magnets in 1978. The third-generation permanent magnet (neodymium-iron-boron with a maximum BH of 40 million Gauss-oersteds) has been developed here and abroad in recent years. The main directions of research on rare-earth permanent magnets are toward further improvement in magnetic energy storage, and development of new high-performance materials, of adhesive magnets and of low-cost rare-earth magnets that do not contain cobalt or samarium.

At present, soft magnets are primarily manganese zinc ferrites. China has made considerable progress in achieving high permeability, high saturation and polarizability, low loss, good stability, good crystalline alignment and single crystals. Although the single-crystal size is still less than that obtained by foreign researchers, the performance and applications are both sound. The crystal properties are as follows: μ_0 = 2000 (at 1 kHz), and 800-1300 (at 5 MHz); B_s = 4050-5300 G; B_r = 378-750 G; H_c = 0.018-0.058 Oe; magnetic induction T_e = 110-130°C; H_v = 600-700; and density = 5.1 g/cm^3.

Amorphous magnetic materials and ferrofluids are attracting interest and attention because of their superior magnetic properties and unique applications. One of the major basic research areas in magnetic materials is magneto-optic studies. Magneto-optic materials can modulate the propagation of light spatially and temporally and hence may be used as optical separators and photothermal magnetic storages. Another research trend is the study of superfine magnetic particles.

Electronics Ceramics

The major categories of electronics ceramics include insulation ceramics, dielectric ceramics, ferroelectric ceramics, piezoelectric ceramics, thermoelectric ceramics, semiconductor ceramics, and conducting ceramics. Most of the ceramics produced are insulation ceramics, piezoelectric ceramics, dielectric ceramics, and sensing ceramics. Sensing ceramics are enjoying the most rapid growth.

Insulating ceramics are used as substrate material and packaging material for integrated circuits. Al_2O_3 ceramics are used the most. In recent years $BN-TiB_2$ and modified SiC ceramics have also been developed. These materials have superior heat-dissipation characteristics and can be used in VLSI circuits.

Dielectric ceramics are used mainly in capacitors and microwave devices. Common capacitor ceramics are magnesium lanthanum titanate, $BaTiO_3$ and $SrTiO_3$. Microwave applications mostly use high-purity aluminum oxide.

Lead zirconate titanate ($PbTiO_3-PbZrO_3$) or PZT is a typical piezoelectric ceramic with an uhligite crystalline structure. The recent trend in materials development has switched to the lead-titanate family of ceramics. Because these ceramics have low dielectric constants (150-200), high Curie temperatures (about 500°C), and a large difference between the thickness coupling constant K_t and the planar coupling constant K_p, they are expected to be useful at high temperatures and high frequencies. In the area of piezoelectric ceramic fabrication technology, research in grain alignment has been active. For example, layered ceramic structures of hot-pressed $PbBi_2Nb_2O_9$, $Bi_4(Pb,Sr)$, and Ti_4O_{15} may have 77 percent of the grains aligned.

Semiconductor ceramics include heat-sensitive resistors, transducers [i.e., sensors], and variable resistors. High-temperature heat-sensitive resistance ceramics have received considerable attention in recent years due to their use as temperature sensors for automobile exhaust and for other industrial applications. Materials developed include fluorite structures (ZrO_2, CaO, and Y_2O_3) and spinel structures (MgO, Al_2O_3, NiO, Cr_2O_3, and Fe_2O_3).

Development of moisture-sensitive, gas-sensitive, and voltage-sensitive ceramics has also been fairly rapid. These materials are mostly sintered metal oxides and thick films such as the moisture-sensitive $ZnO-Cr_2O_3$, $TiO_2-V_2O_5$, and $NiO-Fe_2O_3$ families, and the gas-sensitive SnO_2. The voltage-sensitive ceramic ZnO is a promising semiconductor ceramic developed in the 1970's. Ceramic rheostats made of ZnO have been used in various circuits and devices as over-voltage protectors. In ordinary low-voltage circuits, the maximum surge can be 200J. Better quality ZnO used in high-voltage circuits can stand a surge of 30,000J.

Thermoelectric ceramics are superior materials for infrared sensors. Materials in use are modified $Pb(ZrTi)O_3$-based ceramics and $PbTiO_3$-based ceramics. Their main parameters are listed in Table 2. As a comparison, single-crystal properties are also listed in Table 2.

Table 2. Properties of Principal Thermoelectric Materials

Material	Curie temp T_c(°C)	Dielectric constant ε	Thermoelectric coefficient 10^{-8}(C/cm^{2}K)	Specific heat 10^{-3}(J/kg·K)
Ceramics:				
PZT	220	380	1.8	2.4
PbTiO$_3$	460	190	6	3.2
Single crystals:				
LiTaO$_3$	618	43	1.8	3.2
LiNbO$_3$	1200	30	0.4	2.8

In the rapid development of industrial, defense and consumer electronics, the demand for electronics ceramics will certainly grow. At the present time, the quality of domestic raw material is still unstable, which has caused considerable difficulties for research, development, and production of electronics ceramics. A major task ahead is therefore to improve the quality and production rate of current materials through more in-depth research of the material composition and structure and the effects of process control on material performance. In addition, efforts should be made to actively develop new electronics ceramics.

Fiber-Optic Materials

As the next-generation signal-transmission medium, optical fibers have attracted increasing attention. Fiber-optic materials already developed include quartz glass fiber, multi-component glass fiber, ultra-long-wavelength fiber and plastic fiber. The technological development of quartz fiber has been the fastest. It has gone through the laboratory stage and field applications and reached the industrialized phase.

The developmental status of quartz fiber optics in China is that 0.8-0.9-μm short-wavelength multimode fiber systems and 1.3-μm long-wavelength multimode and single-mode fiber-optic systems are in the application stage, and 1.55-μm long-wavelength single-mode fiber-optic technology is in the developmental and operational stages. The progress of fiber-optic technology in China has been very rapid; short-wavelength and 1.3-μm long-wavelength multimode fiber-optic systems are making the transition from test use to implementation and major advances have been made in the research and development of single-mode systems. The attenuations at 1.3 and 1.55 μm of single-mode fibers developed in China are less than 0.47 dB/km and 0.24 dB/km, respectively. The dispersion in the vicinity of 1.3 μm is less than 3.5 ps/nm·km, meeting the current international standard. Falling behind foreign technology by considerable distance are the mechanical strength of the fibers, reproducibility of the production process, the ability to industrialize the products, the breadth of the applications, and the speed of development.

In the area of non-quartz fiber optics, major advances have been made in recent years on fluoride glass fiber optics; fluoride glass fibers with a low loss of 1 dB/km were developed in 1985.

An overview of the developmental situation of fiber optics indicates that future trends will be toward long-wavelength systems, single-mode systems, and product industrialization.

Conducting Materials

Today's research frontiers in conducting materials are superconductors, conducting polymers and ionic conductors.

Superconductors possess superior electrical and magnetic properties and have become an important base material for new technologies in modern physics, chemistry, biology and medicine. These include the controlled fusion reactor, high-energy particle accelerators, magnetohydrodynamic generators, superconducting computers, and voltage standards. For a long period of time in the past, the superconducting critical temperature has been maintained at 23.3K (Nb_3Ge) and the value for practical applications has been limited.

In 1986 it was discovered in an IBM research laboratory in Zurich, Switzerland, that barium lanthanum copper oxide may have an onset of superconducting transition temperature higher than 35K. After this was confirmed, scientists all over the world plunged into a fevered search for high-critical-temperature superconductors. Within a few months, a number of new superconducting systems were discovered, including barium lanthanum copper oxide, strontium lanthanum copper oxide, barium yttrium copper oxide and strontium yttrium copper oxide, and the superconducting critical temperature was raised above the liquid nitrogen temperature, thus opening up a new era of practical superconductors. In the meantime, research in superconducting thin films has also seen major advances; superconducting thin films with a zero-resistance temperature as high as 89K have been developed. Furthermore, the superconducting critical current at 77K and in a zero magnetic field has reached 14,000 A/cm^2, and the material has been made into ribbons, wires, and fibers. All these developments show that high-temperature superconductors will be entering the practical-use stage. It can be anticipated that the emergence of high-temperature superconductors will have enormous impact on energy, electrical power, electrical machinery, transportation, medicine and the electronics industry.

Conducting polymers are light, flexible, and adjustable in resistivity. They can be divided into structural type and composites. Structural conducting polymers are materials that are intrinsically conducting, such as polyacetylene. Composites are formed by adding conducting materials such as metals, carbon black, graphite, metal oxides and metallic salts in a polymer. For example, conducting thin films formed on plastic films are used in electronic photography, imaging, static prevention, electromagnetic shielding, photographic and magnetic recording. At present, composites are used more widely than structural conducting polymers. The latter have problems in

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processing and stability. One of the future topics in conducting polymers is the development of structural conducting polymers with high performance.

Ionic conductors are primarily used in small batteries, sensors, capacitors, electronic potential-energy storage, and electrochromic display units. Research is expected to continue in ionic conductors containing Zr, Ag, Cu, Li and halides, and possible applications in combustion batteries.

In summary, because of the varied degree of difficulty and technical requirements in different electronic materials, these materials are going through different phases of development. Some have already reached a mature stage and others are still in an exploratory stage. In addition, there are two noteworthy trends in the development of electronic materials abroad. One is the development of new materials in space. Because space has unique conditions of zero gravity, super high temperature, ultrahigh pressure, ultrahigh vacuum, and ultra-low temperature, new materials not possible on earth may be prepared in space [see JPRS-CST-89-001-L, 13 Jan 89, pp 82-95, FOUO]. The other area is the use of biological materials in electronics. It is expected that the energy and signal-conversion mechanisms in biological materials may propel the electronics field into a brand-new age.

Structure-Fatigue Property Relationship in High Strength Low-Carbon
Martensitic Steel

[English abstract of article by Gao Huilin [7559 1920 5259], et al., of Xi'an
Petroleum Institute; Wang Xiaotian [3769 4562 1131] of Xi'an Jiaotong
University]

[Text] An investigation has been made of the relationship between the micro-
structure and fatigue properties in high strength low-carbon martensitic steel.
The results of experiments show that the experimental steel has excellent
fatigue strength and good resistance to fatigue crack propagation when
tempered at low temperatures. The dominant microstructural feature contribut-
ing to fatigue strength involves the dislocated martensitic matrix and carbides
in the martensite, whereas the main contribution to the rate of fatigue crack
propagation involves the orientation difference among adjacent martensitic
packets, martensite lathes and the retained austenite in the form of thin
interlath film. The factors affecting the deterioration of fatigue behavior
in the tempered martensite embrittlement range are also discussed.

References

1. Wang Xiaotian, et al., "Proceedings of the International Conference on
    Martensitic Transformation," Leuven, Belgium, 1982.
2. Gao Huilin, et al., ACTA METALLURGICA SINICA, Vol 24 No 1, 1988.
3. MPDC, "Structural Alloys Handbook," 1, 1975.
4. Peterson, R.Z., "Stress-Concentration Design Factors," 1974.
5. Cox, H.L., "A General Introduction to Fracture Mechanics," 1978.
6. Lai, G.Y., Wood, W.E., Clark, R.A., Zackay, V.F., Parker, E.R., METALL
    TRANS, Vol 5, 1974 p 1663.
7. Thomas, G., METALL TRANS, Vol 9A, 1978 p 439.
8. Zia-Ebrahim, F., Krauss, G., ACTA METALL, Vol 32, 1984 p 1767.

Relationships Between Wear Resistance, Transformation-Induced Martensite
(α Phase), Dislocation Strengthening of Austenitic Medium Manganese Steel

[English abstract of article by He Zhenming [0149 6966 2494], et al., of Jilin Institute of Technology]

[Text] The relationship between wear resistance and transformation induced martensite (α phase), as well as dislocation strengthening of austenitic medium manganese steels under non-severe impact loading conditions, has been studied through TEM, X-ray diffraction, laboratory wear tests and work site tests. The results indicate that, for medium manganese steels with lower austenitic stability, the formation of transformation-induced martensite and its interaction with dislocations can increase the work hardening ability and the wear resistance, while the increase in work hardening and wear resistance of medium manganese steels with higher austenitic stability is the result of the interaction of the solute atoms and the second phase hard particles. Therefore, an effective way of increasing the work hardening ability and wear resistance of austenitic medium manganese steels is to decrease the C and Mn contents and to form a large amount of dispersed fine hard particles, or to increase the concentration of solute atoms.

References

1. He Zhenming, et al., "Proceedings of the Beijing International Casting Conference," Casting Society, Chinese Mechanical Engineering Society, 1986 pp 667-677.
2. Filippov, M.A., et al., PHYSICAL METALLURGY AND HEAT TREATMENT OF METALS, No 5, 1986 pp 31-35.
3. Filippov, M.A., et al., PHYSICAL METALLURGY AND HEAT TREATMENT OF METALS, No 9, 1981 pp 38-40.
4. Jost, N., Schmidt, I., "Wear of Materials," 1985 pp 205-211.
5. Dodd, J., "Climax Molybdenum Company Trends in the Production Utilization and Development of Abrasion-Resistant Alloys in America," 1976.
6. SU 931793, 1982.

7. Fu Shaobai, et al., JOURNAL OF JILIN INDUSTRIAL UNIVERSITY, Vol 1, 1984 pp 93-100.
8. He Zhenming, et al., STEEL, Vol 2, 1983 pp 42-48.
9. He Zhenming, et al., "Selections from the Proceedings of the Third Academic Conference on Metal Abrasion-Resistant Materials," 1986 pp 57-61.

Studies of Toxicity of Methamidophos-A--New Organophosphorus Insecticide for Daphnia Magna Straus*

[English abstract of article by Xiu Ruiqin [0208 3843 3830], et al., of the Institute of Environmental Health and Engineering, Chinese Academy of Preventive Medicine, Beijing]

[Text] Results show that the 24 hour EC_{50} values (median effective concentration) reached 1.88 mg/l (1.48-2.24 mg/l), the 48 hour EC_{50} was 0.49 mg/l (0.49-0.49 mg/l) and the 96 hour EC_{50} was 0.527 mg/l (0.03-0.06 mg/l). The results of no immobilization and 100 percent immobilization concentration for Methamidophos to D. magna were 0.01 mg/l and 0.32 mg/l, respectively, at 96 hours. For the Methamidophos, the 24 hour LC_{50} value (lethal concentration 50) was 56.2 mg/l, the 48 hour LC_{50} value was 161.3 mg/l (130-175 mg/l) and that of the 96 hour LC_{50} was 0.164 mg/l (0.40-0.68 mg/l). The no kill concentration was 0.01 mg/l for 96 hours, while the 100 percent kill concentration was 1.0 mg/l for 96 hours.

Results show that the new organophosphorus insecticide, Methamidophos, is highly toxic to aquatic organisms. The authors indicate that Daphnia magna bioassay methods are rapid, sensitive and inexpensive for environmental toxicological monitoring.

<div align="center">References</div>

1. Xiu Ruiqin, OCEAN AND LAKE BULLETIN, Vol 29 No 3, 1980 pp 77-82.
2. Xiu Ruiqin, et al., PUBLIC HEALTH STUDIES, Vol 14 No 4, 1985 pp 19-22.
3. ISO, "Water Quality Determination of the Mobility of Daphnia Magna Straus," Ref No ISO 6341-1982 (E).
4. APHA AWWA WPCF, "Standard Method for the Examination of Water and Wastewater," 685, 15th ed, APHA, Washington, DC, 1980.

5. EPA, "Water Quality Criteria 1972," National Academy of Sciences, USEPA Research Series, Washington, DC.

6. Bergline, R., Dare, G., BULL ENVIRON CONTAM TOXICOL, Vol 33, 1984 pp 63-68.

Genetic Analysis of Severity Score of Yellow Mosaic Disease in Barley*

[English abstract of article by Yu Zhilong [0205 1807 7127], et al., of the Department of Biology, Hangzhou University; Ma Junhu [7456 0193 5706], et al., of the Crop Institute, Shanghai Academy of Agricultural Science]

[Text] Using Hordeum vulgare L., the genetic analysis of the resistance of barley yellow mosaic virus (BYMV) was carried out in a 7 x 7 diallel set involving a cross of resistant and susceptible barley cultivars during 1984-1986, and was expressed as the severity score. The results obtained showed: (1) The BYMV resistance is adequate in the "additive-dominance" model, but additive gene action is more important than dominant gene action. (2) Both Wr, Vr graph analysis and estimates of the average degree of dominance, $(H_I/D)^{1/2}$, exhibited partial dominance. (3) The number of effective factors (K) showing some degree of dominance was about 3-6. Its application to breeding is briefly discussed based on the results obtained in the current study.

References

1. Huang Peizhong, AGRICULTURE AND ANIMAL HUSBANDRY INFORMATION AND RESEARCH, Vol 8, 1984 pp 39-42.
2. Zhou Xikang, et al., JOURNAL OF PLANT PROTECTION, Vol 12, 1985 pp 217-223.
3. Ruan Yili, ZHEJIANG AGRICULTURAL SCIENCE, Vol 5, 1979 pp 22-27.
4. Yu Zhilong, et al., SHANGHAI AGRICULTURAL JOURNAL, Vol 4 No 3, 1988 pp 29-34.
5. Huang Peizhong, et al., SHANGHAI AGRICULTURAL JOURNAL, Vol 3 No 4, 1987 pp 1-8.
6. Takahashi, T., et al., AGRICULTURAL RESEARCH, Vol 51, 1966 pp 135-152.
7. Takahashi, T., et al., AGRICULTURAL RESEARCH, Vol 52, 1968 pp 65-78.
8. Takahashi, T., et al., AGRICULTURAL RESEARCH, Vol 53, 1970 pp 153-165.
9. Allard, R.W., GENETICS, Vol 41, 1956 pp 305-318.
10. Asher, M.J.C., BARLEY GENETICS, Vol 4, 1981 pp 466-471.
11. Ebratium-Nesbat, Zerlik, G.M., J PLANT DISEASES AND PROTECTION, Vol 91 No 3, 1984 pp 239-243.

12. Friedt, W., PHYTOPATH Z, Vol 106, 1983 pp 16-22.
13. Friedt, W., Foroughi-Wehr, B., in BARLEY GENETICS V (Abstracts), 1986, p 168.
14. Hayman, B.I., GENETICS, Vol 39, 1954 pp 789-809.
15. Hayward, M.D., THEORT APPL GENET, Vol 51, 1977 pp 49-53.
16. Hill, S.A., Evans, E.J., PLANT PATH, Vol 29, 1980 p 197.
17. Huth, W., NACHRICHTENBLATT DES DEUTSCHEN PFLANZENSCHUTZDIENSTES, Vol 36, 1984, pp 49-55.
18. Huth, W., Z PFLANZUCHT, Vol 89, 1982 pp 158-164.
19. Huth, W., et al., PHYTOPATH Z, Vol 111, 1984 pp 37-54.
20. Inouye, T., Saito, J., CMI/AAB DESCRIPTION OF PLANT VIRUS, No 143, 1975 p 3.
21. Johnson, R., EUPHYTICA, Vol 27, 1978 pp 529-540.
22. Jones, I.J., ANN APPL BIOL, Vol 90, 1978 pp 233-239.
23. Kawada, N., Tsuru, M., BARLEY GENETICS V (Abstract), 1986 p 166.
24. Nelson, R.R., J ENVIRON QUALITY, Vol 1, 1972 pp 220-227.
25. Parlevliet, J.E., et al., EUPHYSICS, Vol 29, 1980 pp 1-8.
26. Priestley, R.H., Byford, P., in "UK Cereal Pathogen Virulence Survey Annual Report 1978," 1979, pp 44-48.
27. Ukai, Y., Yamashita, A., JAPANESE J BREEDING, Vol 30, 1979 pp 125-130.
28. Ukai, Y., Yamashita, A., BARLEY GENETICS NEWSL, Vol 14, 1980 pp 31-33.
29. Usugi, T., Saito, Y., ANN PHYTOPATH SOC JAPAN, Vol 42, 1976 pp 12-20.

Isolation, Characterization of New Methanogenic Coccus From Soybean Cake Wastewater*

[English abstract of article by Liu Yutai [0491 5124 1132], et al., of the Institute of Microbiology, Chinese Academy of Sciences, Beijing]

[Text] The methane-producing bacterium strain 8508 was isolated from soybean cake waste digester. This methanogen was a non-motile, irregular coccoid organism (0.5-1.2 µm in diameter) which used H_2-CO_2 and formate as methanogenic substrates. Acetate plus yeast extract or acetate plus trypticase were required for growth. The optimum growth required 0.5-1.0 percent NaCl, which could be replaced by 0.5-1.0 percent $MgCl_2$. The optimal temperature for growth was 35-37°C, with the optimal growth occurring at pH 7.0-7.3. The deoxyribonucleic acid base composition was 41 percent guanine plus cytosine. Methanogen strain 8508 may be a new species of Methanococcus, but it should be fixed with DNA-DNA hybridization of the fluorescent antibody method.

References

1. Hungate, R.E., BACTERIOL REV, Vol 14, 1950 pp 1-49.
2. Liu Yutai, et al., CHINA METHANE, Vol 16 No 4, 1986 pp 3-8.
3. Hungate, R.E., "Methods in Microbiology," Vol 3B, Academic Press, Inc., New York, 1969.
4. Lin Wanming, et al., MICROBIOLOGY, Vol 8, 1981 pp 245-247.
5. Stadtman, T.C., Barker, H.A., J BACTERIOL, Vol 62, 1951 pp 269-280.
6. Balch, W.F., et al., MICROBIOL REV, Vol 43, 1979 pp 260-296.
7. Jones, W.J., et al., ARCH MICROBIOL, Vol 135, 1983 pp 91-97.
8. Corder, R.E., et al., ibid., Vol 134, 1983 pp 28-32.
9. Romesser, J.A., et al., ibid., Vol 121, 1979 pp 147-153.
10. Zabel, H.P., et al., ibid., Vol 137, 1984 pp 308-315.
11. Ollivier, B.M., Mah, R.A., INT J BACTERIOL, Vol 35, 1985 pp 127-130.
12. Ollivier, B.M., et al., INT J SYST BACTERIOL, Vol 36, 1986 pp 297-301.

New Subspecies of <u>Bacillus</u> <u>Thuringiensis</u>

[English abstract of article by Dai Lianyun [2071 5571 7301], et al., of the
Forest Research Section, Chinese Academy of Forestry, Beijing]

[Text] The strain TW20 was isolated from a soil sample collected in Beijing.
Morphological observation showed that the vegetative cell was not motile.
It was gram positive with rod dimensions of 1.2-1.5 x 4.0-5.0 µm. Parasporal
inclusion was irregular in shape. An electron micrograph of a thin section
of TW20 at the sporangium stage showed a few parasporal inclusions irregular
in shape. The biochemical characteristics and esterase type of strain TW20
are different from all reference standard strains. Bioassays on larvae have
shown that the new strain TW20 has no pathogenicity against <u>Dendrolimus</u>
<u>tabulaeformis</u> (a type of caterpillar), <u>Lymantria</u> <u>dispara</u> (moth), <u>Malacosoma</u>
<u>neustria</u> <u>testacea</u> (caterpillar) or <u>Anoplophora</u> <u>glabripennis</u> (long-horn beetle
(longicorn)).

On the basis of the aforementioned characteristics, the authors propose the
name <u>Bacillus</u> <u>thuringiensis</u> subsp. wenguanensis for the type strain TW20.

References

1. Norris, J.R., J APPL BACT, Vol 27 No 3, 1964 pp 439-447.
2. de Barjac, H., "Microbial Control at Peses and Plant Diseases 1970-1980,"
    ed. by H.D. Burges, Academic Press, London, 1981 pp 35-43.
3. Delucca, A.J., et al., J INVERT PATH, Vol 43, 1984 pp 437-438.
4. Wang Ying, et al., ACTA MICROBIOLOGICA SINICA, Vol 26 No 1, 1986 pp 1-6.
5. Ohba, M., et al., J INVERT PATH, Vol 48, 1986 pp 129-130.
6. Lin Zhaolin, et al., "Collected Papers of the Forestry and Pedology
    Research Institute, Chinese Academy of Sciences," No 6, Science Press,
    Beijing, 1983 pp 169-178.
7. Dai Lianyun, et al., MICROBIOLOGY, Vol 14 No 3, 1987 p 100.
8. Dai Lianyun, et al., FORESTRY SCIENCE, Vol 23 No 1, 1987 pp 91-93.
9. Ohba, M., et al., J INVERT PATH, Vol 38, 1981 pp 184-190.

10. Bacterial Classification Group, Institute of Microbiology, Chinese Academy of Sciences, "Typing Methods for Common Bacteria," Science Press, Beijing, 1978.
11. Mang Keqiang, et al., "Polyacrylamide Gel Electrophoresis," Science Press, Beijing, 1975.
12. Gordon, R.E., et al., (Cai Shaoying, trans.), "Bacillus," Agricultural Press, Beijing, 1983.
13. Buchanan, R.E., et al., "Bergey's Manual of Determinative Bacteriology," 8th ed., Williams and Wilkins Company, Baltimore, 1974 p 536.
14. Chen Tao, et al., JOURNAL OF ELECTRON MICROSCOPY, Vol 5 No 4, 1986 pp 20-30.
15. Dai Lianyun, et al., FORESTRY SCIENCE RESEARCH, Vol 1 No 3, 1988 pp 285-288.
16. Ohba, M., et al., J INVERT PATH, Vol 47, 1986 pp 277-282.

Role of uvrA Gene in Screening of Genotoxins in SOS Chromotest

40091020c Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 28 No 4, Dec 88 pp 313-318

[English abstract of article by Chen Zhongfu [7115 0022 1318], et al., of the Institute of Genetics, Fudan University, Shanghai]

[Text] A total of 45 different chemicals, including carcinogens, antitumor agents, base analogs, metabolite inhibitors, food additives and wastewater, was screened for genotoxicity using the SOS chromotest. Escherichia coli uvrA⁻ strain PQ37 and uvrA⁺ strain GC4415 were used to define the role of the uvrA gene in the SOS chromotest. Generally, the uvrA⁻ strain PQ37 was very sensitive in the SOS chromotest, while with strain GC4415, the authors failed to detect the genotoxicity of nitrocaphane, acridine yellow and a series of analogs of daunomycin. On the other hand, it has been observed that for some chemicals, such as mitomycin C, nalidixic acid and methotrexat, the SOS inducibility of strain PQ37 is lower than that of strain GC4415. It has been known that the ability of certain chemicals to induce SOS responses depends partly on the uvrA⁺ gene product. Therefore, it is preferable to use the uvrA⁺ and uvrA⁻ strains together in the SOS chromotest when screening genotoxins as the authors did in this study.

<div align="center">References</div>

1. Quillardet, P., et al., MUTATION RES, Vol 147, 1985 pp 79-95.
2. Quillardet, P., et al., PROC NATL ACAD SCI, Vol 79, 1982 pp 5971-5975.
3. Levin, D.E., et al., ibid., Vol 79, 1982 pp 7445-7449.
4. Murayama, I., et al., MUTATION RES, Vol 18, 1973 pp 117-119.
5. Quillardet, P., et al., ibid., Vol 147, 1985 pp 65-78.
6. Palajda, M., et al., ibid., Vol 153, 1985 pp 79-134.
7. Yamamoto, K., et al., ibid., Vol 149, 1985 pp 297-302.

Phosphate Control to Rifamycin SV Biosynthesis

[English abstract of article by Ni Liuying [0242 2839 5391], et al., of Shanghai Institute of Plant Physiology, Chinese Academy of Sciences]

[Text] In this report, the inhibitory effect of inorganic phosphate on rifamycin SV biosynthesis is studied. When inorganic phosphate was added at the trophophase (0-48 hours) of the fermentation, a pronounced suppression of rifamycin SV synthesis and a more rapid culture growth were found. The earlier the addition of phosphate, the more severe the inhibitory effect was.

In order to explain the possible mechanisms for this phosphate inhibitory effect, the authors assayed the lipid content, enzyme activity and adenylates content in the mycelia. First, when the inorganic phosphate (5 mmol/L) was added at the beginning of the fermentation, the mycelial lipid content was increased to 353 mg/g dry weight, whereas that of the control mycelia was 207 mg/g dry weight. Then, the activities of methylmalonyl-coenzyme A carboxyltransferase and methylmalonyl-coenzyme A mutase were suppressed by the increased concentration of inorganic phosphate. Finally, the increased level of inorganic phosphate caused a marked improvement in the levels of ATP and ADP, as well as AMP content, and the energy charge was enhanced by the addition of inorganic phosphate.

A scheme correlating the results observed above is suggested, and further study is necessary to explain the target reactions brought about by the excessive amount of inorganic phosphate. It is possible that the variation in the adenylate pool may function as the intracellular effector.

References

1. Hostalek, Z., FOLIA MICROBIOL, Vol 9, 1964 pp 78-88.
2. Perlman, D., et al., J BACTERIOL, Vol 63, 1951 pp 253-262.
3. Martin, J.F., ADV BIOCHEM ENG, Vol 6, 1977 pp 105-127.
4. Weinberg, E.D., DEV IND MICROBIOL, Vol 15, 1974 pp 70-81.
5. Mardry, N., et al., EUR J APPL MICROBIOL BIOTECHNOL, Vol 7, 1979 pp 365-370.

6. Vu-Trong, K., et al., ANTIMICROB AGENTS AND CHEMOTHER, Vol 19, 1981 pp 209-212.
7. Liu, C.M., et al., ANTIMICROB AGENTS AND CHEMOTHER, Vol 7, 1975 pp 196-202.
8. Martin, J.F., et al., BIOCHEM BIOPHYS RES COMMUN, Vol 71, 1976 pp 1103-1109.
9. Martin, J.F., ANN REV MICROBIOL, Vol 31, 1977 pp 13-38.
10. Vining, L.C., "Biochemistry and Genetic Regulation of Commercially Important Antibiotics," Addison-Wesley Publishing Company, London, Amsterdam, Don Mills, Ontario, Sydney, Tokyo, 1983 pp 194-196.
11. Vu-Trong, K., et al., ANTIMICROB AGENTS AND CHEMOTHER, Vol 17, 1980 pp 519-525.
12. Kellermeyer, W., et al., "Methods in Enzymology," (ed. J.M. Lowenstein), Academic Press, Vol 13, 1969 pp 207-215.
13. Lowry, P.H., et al., J BIOL CHEM, Vol 193, 1951 p 265.
14. Simon, E.J., et al., SUCCINYL COTL J AM CHEM SOC, Vol 75, 1953 p 2520.
15. Li Liren, et al., DEVELOPMENTS IN BIOCHEMISTRY AND BIOPHYSICS, Vol 6, 1980, pp 60-62.
16. Stephen, W.D., et al., "Secondary Metabolism and Differentiation in Fungi," (ed. Bennett, J.W.), Alex Elegler, New York and Basel, 1983 pp 35-54.
17. Gersch, D., PROC BIOCHEM, Vol 15, 1980 pp 21-25.
18. Birch, A.J., et al., TETRAHEDRON LETT, 1964 p 1485.
19. White, R.J., et al., NATURE, Vol 243, 1973 p 273.
20. Martin, J.F., et al., BIOCHEM BIOPHYS RES COMMUN, Vol 83, 1978 pp 822-828.

Isolation, Purification, Antiserum Preparation of Potato Leaf Roll Virus

[English abstract of article by Zheng Heling [1728 7729 7881], et al., of the Department of Biology, Inner Mongolia University, Huhehaose]

[Text] Potato leaf roll virus (PLRV) was isolated from potato varieties B76-16 x 292-20 and Mira and was purified by differential centrifugation, followed by filtration through a Sephadex G-200 column and density gradient centrifugation, using infected virus-free potato plants and Physalis floridana as the source of the virus. Uniform isometric particles with diameters of 23.98 nm were observed. An antiserum against isolated PLRV with a titer of 1/4096 in counterimmunoelectrophoresis was prepared. The PLRV in infected potato leaf extracts was detected by counterimmunoelectro-phoresis. This is the first report on the isolation, purification and anti-serum preparation of potato leaf roll virus in China.

References

1. Aria, K., et al., ANN PHYTOPATHOL SOC JAPAN, Vol 35, 1969 pp 10-15.
2. Sarkar, S., VIROLOGY, Vol 770, 1975 pp 265-273.
3. Sarkar, S., ABSTRACTS 3RD CONGRESS PLANT PATHOL, Vol 54, 1978 p 1.
4. Rowhani, A., et al., VIROLOGY, Vol 93, 1979 pp 45-54.
5. Murayama, D., et al., PROC JAPAN ACAD, Vol 50, 1974 pp 322-327.
6. Maat, D.Z., et al., NETH J PL PATH, Vol 84, 1978 pp 149-156.
7. Gugerli, P., PHYTOPATH Z, Vol 96, 1979 pp 97-107.
8. Tamada, T., et al., ANN APPL BIOL, Vol 95, 1980 pp 209-219.
9. Casper, R., PHYTOPATH Z, Vol 90, 1977 pp 364-368.
10. Gugerli, P., et al., POTATO RES, Vol 23, 1980 pp 353-359.
11. Tamada, T., et al., ANN APPL BIOL, Vol 96, 1980 pp 67-78.
12. Roberts, I.M., et al., ibid., Vol 93, 1979 pp 289-297.
13. Cleora, J., et al., PHYTOPATHOLOGY, Vol 73, 1983 pp 755-759.

Growth Properties of CEV-Gynura Aurantiaca Cell Suspension System

[English abstract of article by Xiong Cuiying [3574 5050 5391], et al., of Wuhan Institute of Virology, Chinese Academy of Sciences; Hou Songsheng [0186 1529 3932] of Wuhan Institute of Botany, Chinese Academy of Sciences]

[Text] Gynura aurantiaca DC is a sensitive indicator plant of Citrus Exocortis Viroid (CEV). Healthy G. aurantiaca plants inoculated mechanically with ground CEV preparation from infected citrus leaves were used as the source of the CEV-infected explant. The authors induced and subcultured healthy and CEV-infected G. aurantiaca leaflet calli in MS and B_5 agar media, and established healthy and CEV-infected cell suspension cultures in MS and B_5 liquid media. Nucleic acid extracted from healthy and CEV-infected calli and suspension cells was analyzed on bidirectional 5 percent polyacrylamide gel. Silver staining demonstrated that the characteristic CEV band was not present in extracts from healthy G. aurantiaca calli and suspension cultures, but all cultures derived from CEV-infected G. aurantiaca contained the viroid. CEV can replicate in mitotically active dividing cells of the suspension culture, and the calli and cell suspensions can be easily subcultured and maintained.

References

1. Diener, T.O., (Liu Yong, et al., trans.), "Viroids and Viroid Diseases," Science Press, Beijing, 1985.
2. Conejero, V., et al., VIROLOGY, Vol 97, 1979 pp 454-456.
3. Marton, L., et al., VIROLOGY, Vol 122, 1982 pp 229-238.
4. Takabashi, T., et al., VIROLOGY, Vol 64, 1975 pp 106-114.
5. Muhlbada, H.P., et al., J GEN VIROL, Vol 35, 1977 pp 377-386.
6. Schumacher, J., et al., ANALYTICAL BIOCHEMISTRY, Vol 135, 1983 pp 288-295.
7. Zhou Yongzhi, JOURNAL OF VIROLOGY, Vol 3 No 3, 1987 pp 277-281.
8. Semancik, J.S., et al., VIROLOGY, Vol 80, 1977 pp 218-221.
9. Zhou Yongzhi, et al., CHINA CITRUS, Vol 1, 1986 pp 15-16.
10. Zelcer, A., et al., VIROLOGY, Vol 109, 1981 pp 314-322.
11. Gui Huilin, et al., ed., "Plant Cell Culture," Science Press, Beijing, 1985.

Electron Microscopic Observations of Brucella Canis Isolated in China

[English abstract of article by Xie Nianming [6200 1819 6900], et al., of the National Institute for the Control of Pharmaceutical and Biological Products, Beijing]

[Text] Four strains of Brucella canis isolated in China and four species of Brucella, including B. canis, B. melitensis, B. aborts and B. suis, from WHO were studied with an electron microscope. Chinese strains resembling the coccobacilli were similar to WHO's in form and size. The cocco-form has a diameter of 0.7-0.73 μm. Capsules, flagella and endospores were not present. The thin section profile revealed the gram-negative cell wall structure composed of a peptidoglycan layer and outer membrane.

On the cell surface of the Chinese strains nipples, composed of the outer membrane and peptidoglycan, were always present. Therefore, the nipple is a part of the cell wall. Since the outer membrane is composed of lipo-polysaccharide (LPS), the nipples may well be a form which secretes the bacterial endotoxins.

More trident-form cells were found in WHO's strains. They are caused by lateral divisions. However, the general reports deem that bacteria propagate only by transverse segmentation.

References

1. Harris, J.R., "Microscopy of Proteins," Vol 3, Academic Press, London, 1982 pp 41-66.
2. Inouye, M., "Bacterial Outer Membrane," Wiley Inner-Science, New York, 1979 pp 503-507.
3. Jeljaszewicz, J., et al., "Bacterial Toxins and Cell Membranes," Academic Press, London, 1978 pp 60-73.
4. Bradley, S.G., ANN REW MICROBIOL, Vol 33, 1979 pp 67-94.

Vibrio Cholerae Gene Expression in E. coli Studied

[Article by Ma Qingjun [7456 3237 6874], Zhou Jianguang [0719 1696 0342], Yu Xiuqin [0060 4423 3830], and Xu Yongqiang [1776 3057 1730], Biological Engineering Institute, Military Medical Science Academy, Beijing: "Vibrio Cholerae Toxin Gene Expression in E. coli" (A National Natural Sciences Fund financially assisted project)]

[Text] When a V. cholerae gene is expressed in E. coli, the toxin generated in the E. coli has the same bioactivity, antigenicity, and immunogenicity as cholera toxin. However, 90 percent of the cholera toxin produced is retained within the cells where its toxicity can be activated by trypsin.

Key Terms: Cholera toxin; gene expression; and E. coli

Cholera, which is caused by V. cholerae, is a fulminating infectious disease of the intestinal tract. During the past more than 20 years, major advances have been made in the study of the physical and chemical properties of cholera toxin, its biological activity, its molecular structure, and its operating mechanism. Cholera toxin is made up of one A sub-unit and five B sub-units, the two being held together by a non-covalent bond. The molecular weights of the two sub-units are 28,000 and 11,600 respectively. The A sub-unit is the active part in toxicity, and the B sub-unit is the antigenetic part of the toxin. The conjugation of the B sub-unit and the epithelial cell receptors (gangliosides GM1) of the little intestine mucosa enables the A sub-unit to pass through the cell membrane and react with the adenosine cyclase in the intracellular membrane causing the ATP in the cell to become cAMP, as well as causing a marked increase in the concentration of cAMP in the cell. This stimulates the intestinal mucosa cells to secrete, and a large amount of intestinal fluid is secreted, causing serious vomiting and diarrhea.

The cholera enterotoxin gene is located on a chromosome, and we used genetic engineering techniques to isolate this gene and successfully

clone it into E. coli.[1] This article reports the toxicity, antigenicity, and immunogenicity of the cholera toxin generated by the cholera toxin gene clone in the E. coli, and the characteristics of its expression in the E. coli.

Materials and Methods

(1) Bacteria Strain

V. cholerae 569B (classic biotype and paddy leaf serum type) were provided by the Pharmaceutical and Biological Products Identification Institute of the Ministry of Health. E. coli RR1 (pMM-CT) was a cholera toxin gene cloned bacteria strain constructed by our own laboratory.

(2) Toxin and Antitoxin Serum

Purified cholera toxin was a Sigma Company product, and anti-cholera toxin serum was secured through the laboratory's use of the Sigma Company cholera toxin product to immunize rabbits.

(3) Toxin Production

The bacteria were grown in an LB broth culture at 37 degrees C, the culture being agitated and aerated for 18 hours. The culture was centrifuged and the supernatant removed, becoming an acellular culturing solution (S) sample. The collected cells were suspended in a 25 percent sucrose, 50 m mol/L Tris-HCl, 0.12 m mol/L EDTA (pH 7.5) buffering solution. After lysozyme (1 mg/ml), $NP_{40(0.2\%)}$ cleavage, the solution was centrifuged and the supernatant removed to make a cell cleavage extract (E) sample.

(4) Toxin Toxicity Analysis

Rat Y1 adrenal gland cells were assayed using the procedures described in references [2] and [3]. Rabbit ileal loop ligation tests were conducted using the procedures described in reference [4].

(5) Toxin Immunogenicity Analysis

Cyan rabbits (males, weighing 2 kg) were immunized either through intramuscular injection or orally, Freund's adjuvant being used for intramuscular injection. In oral immunization, perfusion with 0.1 mol/L $NaHCO_3$ was done before perfusion with the antigen. The challenge toxin test used a small intestine ileal loop ligation challenge, and the hydrops reaction in the small intestine section was assayed.

(6) Toxin Antigenicity Analysis

A passive immunohemolysis experiment was performed using the Serafim method described in reference [5]. A GM1-ELISA experiment was conducted using the Sack method described in reference [6].

Results

(1) Biological Activity of Cholera Toxin Produced by E. coli

Rat Yl adrenal gland cell assay, and rabbit ileal loop ligation testing
of the cholera toxin produced by the pMM-CT cloned into the E. coli
showed the same bioactivity as the cholera toxin produced by V.
cholerae, and this toxic action could be specifically neutralized by
anti-cholera toxin serum.

1. Yl adrenal gland cell assay: The Yl adrenal gland cell was very
sensitive to the action of the cholera toxin, which produced
morphologically variable pathological changes in the cell. Results of
the assay showed that both the E. coli RR1 (pMM-CT) and the V. cholerae
569B culturing solution could cause the Yl cells to vary. The E. coli
RR1 (pBR322) that was used as a control was unable to produce a change
in the Yl cell morphology.

2. Rabbit ileal loop ligation test: In the rabbit ileal loop ligation
test, both the V. cholerae 569B acellular culturing solution and the
cell cleavage solution contained cholera toxin, which produced between
1.5 and 1.8 ml/cm of fluid accumulation in the intestinal cavity. The
E. coli RR1 (pMM-CT) acellular culturing solution caused the
accumulation of 1.2 ml/cm of fluid in the intestinal cavity. The cell
cleavage solution produced 1.5 ml/cm. In the case of the E. coli RR1
(pBR322), neither the cell culturing solution nor the cell cleavage
solution produced fluid accumulation.

(2) Antigenicity of E. coli Generated Cholera toxin

1. Passive immunohemolysis test: Passive immunohemolysis testing was
done to assay the antigenicity of the cholera toxin that both the V.
cholerae and the E. coli pMM-CT clone produced. The results showed
clearly that the acellular culturing solution and the cell cleavage
extract from the V. cholerae 569B produced marked hemolysis. The E.
coli pMM-CT clone's acellular culturing solution was only slightly
hemolytic, but the cell cleavage solution produced marked hemolysis.
Neither the acellular culturing solution nor the cell cleavage solution
from the plasmid-containing pBR322 E. coli produced hemolysis. When
anti-cholera toxin serum was added in advance to the specimen that
produced hemolysis in an inhibition test, results turned negative
showing the assayed cholera toxin antigen reaction to be specific.

2. Ganglioside GM1-ELISA assay: A ganglioside-enzyme linked
immunosorbent assay was made of the acellular culturing solution and the
cell cleavage extract from the V. cholerae 569B and E. coli pMM-CT
cloned strain to assay cholera toxin antigenicity. Results were
positive. All P/N values were greater than 2.4. If serum containing
anti-cholera toxin were added to the specimen first, and inhibition
testing done, assay results turned negative, and the pBR322 plasmid-
containing E. coli used as a control was negative.

The above two tests showed that the cholera toxin produced in the E. coli pMM-CT clone possessed cholera toxin antigenicity.

(3) Immunogenicity of E. coli Produced Cholera Toxin

Cholera toxin antigens from the pMM-CT clone strain cell cleavage extract were used to immunize rabbits either through intramuscular injection or orally. Fundamental immunization was done three times at 10 day intervals, the dosage being 300 ng each time. To the first intramuscular injection was added Freund's complete adjuvant. Freund's incomplete adjuvant was added to subsequent injections. In oral immunization, before perfusion of antigens, perfusion was done using 10 ml of 0.1 mol/L $NaHCO_3$ solution. One month after the fundamental immunization, a booster immunization was given, and 7 days after the booster immunization, 10 ng of cholera toxin were used in an ileal loop ligation challenge. Results (Figure 5) showed that both the intramuscularly injected and the orally dosed rabbits produced a certain amount of immunity. Each intestine segment was able to tolerate a 10 ng toxin challenge, and the average amount of fluid collected in each segment was between 0.2 and 0.3 ml/cm. In rabbits not immunized with toxin antigens, the average amount of fluid that collected in intestine segments was 2.0 ml/cm showing that the cholera toxin antigen produced by the pMM-CT cloned strain possessed immunogenicity.
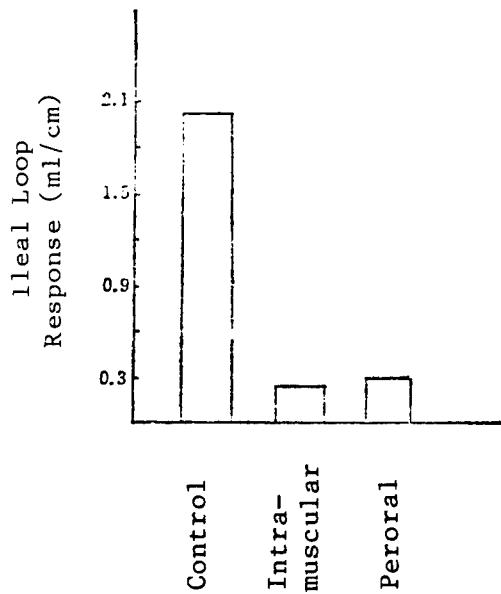
Figure 5. Effect of Immunization with RR1 (pMM-CT-CT) Extracts on Ileal Loop Response to Challenge With Cholera Toxin

(4) Characteristics of Cholera Toxin Gene Expression in E. coli

Toxicity and antigenicity of the acellular culturing solution and the cell cleavage extract from the E. coli RR1 (pMM-CT) and the V. cholerae 569 B culture were assayed and compared. Observed characteristics of cholera toxin gene expression in E. coli are shown in Table 1. Table 1 shows:

1. Cholera toxin antigen genes can produce cholera toxin antigens in E. coli; however, 90 percent are retained within the cells, while 90 percent of the toxin antigen produced by V. cholerae is released outside the cells into the culturing solution.

2. Toxicity of the toxin produced by cholera toxin genes in E. coli can be activated by trypsin, suggesting that the cholera toxin produced by E. coli are a precursor kind that require additional protease processing to express their full virulence.

3. The number of cholera toxin gene copies in the E. coli RR1 (pMM-CT) is greater than in V. cholerae 569B, but expression of toxin antigens is only 1 percent that produced by V. cholerae.

Table 1. Production of Cholera Toxin in Liquid Culture

Sample*	Toxin Antigen** (ng/ml)	Specific Toxicity*** (ng/ml)
569B-S	1000	1000
569B-E	10	10
RR1(pMM-CT)-S	1	1
RR1(pMM-CT)-E	10	10
RR1(pMM-CT)E + Ab	0	0
RR1(pMM-CT)E + T	10	100
RR1(pBR322)E + T	0	0
RR1(pMM-CT)E + T + Ab	0	0

* Strains were grown in LB medium and supernatant (S) and cell extracts (E) were prepared. Extracts were treated with antibody (+Ab) by addition of 1 μl of rabbit antitoxin per 100 μl of sample, followed by incubation at 37 degrees C for 30 minutes. Extracts were treated with trypsin (+T) by addition of the enzyme to a final concentration of 200 μg/ml followed by incubation at 37 degrees C for 15 minutes.

** Measured by ELISA.

*** Measured by Y1 adrenal cell assay.

Discussion

The cholera toxin gene expressed in the E. coli, and the bioactivity and antigenicity of the toxin produced was like that of the cholera toxin. It could be specifically neutralized by anti-cholera toxin serum, and it possessed immunogenicity. After rabbits had been immunized either through intramuscular injections or orally, they possessed a certain amount of protection.

The toxin produced by the cholera toxin gene in the E. coli existed mostly outside the cells, but the cholera toxin produced through expression in the E. coli existed mostly inside the cells. Pearson and Mekalanos[7] believe that E. coli lack the organs necessary for protein secretion, or else they are unable to identify cholera toxin secretion signal peptides. We transformed toxic genes A^+B^+ into A^-B^+ clones. The toxin B sub-unit antigens that the E. coli produced were secreted outside cells for the most part (results to be reported in a separate article), showing that E. coli can identify cholera toxin polypeptide secretion signals, and can also send it outside cells for processing. Therefore, not only is protein secretion outside the cells related to secretion signal peptides and the processing capabilities of host bacteria, but other mechanisms are related to the make up and molecular size of structural protein.

The reason for the low expression of cholera toxin genes in E. coli is related to the inability of E. coli to identify effectively the cholera toxin gene promoters, as well as a lack of direct modulators that enable toxin genes to produce high expression.[8] An additional important reason is the catabolic destruction of toxin in cells by E. coli protease. We put RR1 cell cleavage solution into toxin produced by V. cholera, and incubated it at 37 degrees C for 30 minutes. Ninety percent of antigen activity was lost; therefore, the role of protease in breaking down accumulated toxin in E. coli cells cannot be underestimated.

References

[1] Ma Qingjun, et al.: Biological Engineering Journal, 3: 24, 1987.

[2] Tang Hongdi [0781 4767 1229], et al.: Infectious Diseases of Livestock, 3: 28, 1985.

[3] Sack, D. A.: Infect.: Infect. Immun., 11: 334, 1975.

[4] Ahren, C. M.: Infect. Immun., 38: 74, 1982.

[5] Serafim, M., et al.: Infect. Immun., 24: 606, 1979.

[6] Sack, D. A., et al.: J. Clin. Microbiol., 11: 35, 1980.

[7] Pearson, G. W. N., et al.: PNAS, USA, 79: 2976, 1982.

[8] Mekalanos, J. J.: J. Bacteriol., 141: 570, 1980.

BRIEFS

DNA Synthesis Reagents--Fifteen chemical reagents required for DNA synthesis have been developed and manufactured by the Shanghai Cell Biology Institute of the Chinese Academy of Sciences. Due to its substantial value in the diagnosis of genetic and viral diseases, in animal, plant, and food inspections, and its use in medical jurisprudence, the DNA synthesis project has thus been listed as a "Seventh-Five-Year Plan" key subject. The success in developing and producing the 15 reagents including four medicines and four solid vectors will fully meet the needs of the reagents for DNA synthesis research in the nation. The application of the chemically synthesized DNA in detecting hepatitis A virus in clams demonstrates the great advantage, accuracy, and speed of this new technique, which takes only 2 to 3 days to detect the hepatitis A virus instead of the 1 to 2 months previously required. [40081022a Shanghai JIEFANG RIBAO in Chinese 13 Jan 89 p 1]

Gene-Engineered Human Epithelium Growth Factor (hEGF)--The Institute of Basic Medicine of the Chinese Academy of Medical Sciences has successfully produced a human epithelium growth factor from yeast through gene recombination techniques. China and West Germany are the only two nations capable of producing hEGF. In 1975, scientists verified that hEGF, an active peptide extracted from urine, is able to inhibit gastric acid secretions and promote cell growth. The peptide is an excellent element for cell culture and an ideal medicine for gastric ulcer treatment. It can also be used as a central nervous system controlling factor because of its human enkephalin activity. The three expression-plasmids made by the institute by inserting human epithelium cell growth factor gene fragments into yeast receptor cells have very high expression efficacy and great economic value. It produces 4 mg/cubic centimeter with a purity of 99.93 percent. [40081022b Beijing GUANGMING RIBAO in Chinese 8 Jan 89 p 2]

Superfine Snake Venom--A new generation of superfine snake venom has been jointly developed and produced by the Shanghai Zhenxing Chinese Traditional Medicine Science and Technology Development Corporation, the Shanghai Huangshan Pharmaceutical Company, and the Shanghai Institute of Biological Products. The product is used in the treatment of cerebral thrombosis, heart attack, and malignant tumors. The cure rate of cerebral thrombosis obtained clinically at the Chinese Medical University was 88 percent; the success rate was 96.2 percent for heart attack when tested at the Shenyang Military Regional Hospital. The preparation has also been used to treat some 20,000 tumors at the Shanghai Xinle Sector Hospital. [40081022c Shanghai Wen Hui Bao in Chinese 19 Dec 88 p 2]

AI Computer System LISP-M1

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received 3 Aug 87]

[Text] Abstract

The artificial intelligence (AI) computer LISP-M1 system is a LISP
system which we designed and developed. This article provides a
preliminary analysis of its design program and a performance evaluation.

Key words: artificial intelligence; computer systems; algorithms;
performance analysis

0. Introduction

Using conventional program design languages to solve AI questions often
requires much effort, and a language's inadequate representational
capability can sometimes cause problems. Thus, a suitable AI program
design language must be chosen when solving AI problems or designing AI
systems. At present, AI program design languages only number in the
tens, and only two are used in a rather broad range of applications:
LISP and PROLOG. Both have their own advantages, but LISP is the oldest
(LISP-1.5 was published in 1962) and more AI programs are written in
LISP. Its flexibility in research work has generated over 100 different
LISP dialects. Work on an earlier common dialect of LISP called COMMON
LISP began after the First International LISP Symposium in 1980. A draft
COMMON LISP document was published in 1984[1]. It has common
characteristics with modern LISP, a rather rich representational
capability, and strong program transferability. Most recent newly-
written LISP systems are based on or include it. There are more than 10,

including VAX COMMON LISP, GOLDEN COMMON LISP, S-1 COMMON LISP, DG COMMON LISP, KYOTO COMMON LISP, and others. Thus, using COMMON LISP as a basis for designing new AI systems can give a program stronger capabilities and transferability, enabling circulation and utilization of existing AI software. The LISP-M1 system uses COMMON LISP (expandable subset) as the system language document.

An interpretation system or compiling system in the LISP language usually has a rather low rate of efficiency when used in conventional computers. To increase the speed, the computer's system architecture must be reformed to adapt it to run programs written in the LISP language. This type of computer is usually called a LISP computer. They have developed rather quickly since the 1970's and many types of LISP computers are now being sold as products[2]. They include the XEROX 1100 series (1981), SYMBOLICS 3600 series (1983), LMI-LAMBDA (1983), FUJITSU-ALPHA (1983), TELETRONICS 4400 series (1984), TEXAS INSTRUMENTS EXPLORER (1984), and others. Generally speaking, under identical circuit conditions, LISP computers are quantitatively one numerical grade higher than conventional computers. At present, China has no LISP computer products and none have been imported. This gives LISP computers great significance in AI research, particularly for national defense modernization. The AI computer LISP-M1 system is a LISP computer we designed and developed which uses COMMON LISP as a language document. This article provides a preliminary analysis of its design program and a performance evaluation.

I. Overall Structure of the LISP-M1 System

The system architecture of LISP computers can be divided into three categories:

1. Specially configures LISP computers using integrated circuits;

2. Parallel processing systems composed of general-purpose computers combined with certain special processors and oriented toward the LISP language;

3. LISP computers composed of VLSI [very-large-scale integrated] circuits, such as monolithic LISP computers.

The LISP-M1 system architecture belongs to category 2. It contains three interlinked parallel operation components (Figure 1):
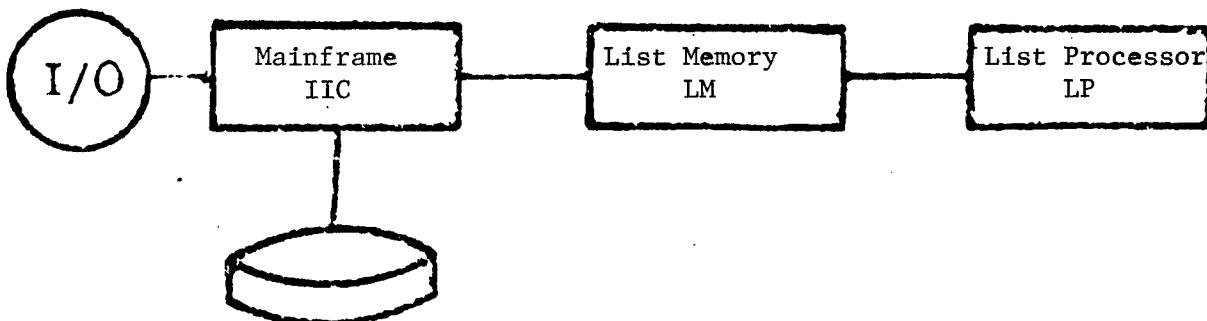
Figure 1. Overall LISP-M1 Architecture

1. Mainframe-includes a general-purpose microcomputer system and special interfaces

2. List processor

3. List memory-shared high-capacity memory

This system architecture evolved from a previous LISP system[3]. There are a total of five processes in the LISP-V3 interpretation system, with channels interconnecting them. Under normal conditions, the channels occupy only an extremely small portion during transmission. In the LISP-PC interpretation system, all internal storage space outside that set aside from the DOS operating system serves as independently chained node space, which expands the usable space several times. Experience in developing this system provided a basis for LISP-M1 design and inspiration.

Based on LISP language characteristics, the LISP-M1 system uses a functionally distributed multilevel parallel architecture. The first level is parallel operation among the three components listed above. The second level is parallel operation within each component. The basic operating pattern is:

1. The mainframe provides the user with software tools and support environment. The LISP "pre-processing program" in the mainframe converts a user-input program written in LISP into intermediate codes and then transmits them via an interface to a special area in the list memory.

2. The list processor selects the intermediate codes from this special area and then interprets and executes them. The results of interpretation come in two forms:

a. New data structures and information are formed within the list processor and list memory.

b. Results are sent to another special-purpose transmission region of the main memory.

3. The mainframe "post-processing program" selects commands and information from this special-purpose region. After additional processing, the processing results are output to the user or peripherals.

This type of system architecture has the following advantages:

1. The list processor specially executes LISP chained-list processing, function evaluation, and other operations. Remaining operations like pre-processing, support environment, post-processing, and so on are handled by a general-purpose microcomputer. This can streamline the architecture of the list processor, use the advantages of parallel processing, and give the system a higher performance/cost ratio.

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2. General-purpose microcomputer system software and hardware resources can be used to shorten development schedules and make system implementation easier.

3. The high-capacity memory gives the system list node space to provide large amounts of data needed for AI programs.

4. The three main parts are interlinked only through boundaries. By maintaining the boundaries unchanged, each part can be modified, facilitating system updating and replacement and series formation.

II. List Processor

2.1 Architecture

The list processor LP is a microprogram-controlled special-purpose processor oriented toward chained-list processing. It has the following architecture:

2.1.1 Tagged system architecture. LISP-M1 uses a tagged data format to achieve dynamic data type detection, accelerate chained-list processing, reduce memory space, and other things. The basic data format is 32 bits divided into two fields:

Tag field	8 bits, including:
Garbage collection tag	1 bit
cdr code	2 bits
Data type code	5 bits
Address field	24 bits

The list processor hardware architecture uses the following functions to support this type of data architecture:

a. High-speed tag generation, extraction, assembly, revision, and detection

b. Using tags for direct control of flow path transfer in the interpretation process

2.1.2 Hard stack. A rather large high-speed hard stack is installed in the list processor, which accelerates field conversion of recursive calls, partial variable access, variable constraints, and other processes. This greatly reduces memory inquiries and solves memory "bottlenecks".

2.1.3 Microprogram control. The list processor uses a microprogram to interpret intermediate codes semantically similar to LISP to reduce semantic differences between machine language and LISP. This enables

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full use of list-processor hardware architecture functions, and tags in the data format can be used directly to control the microprogram flow path. The microprogram is loaded dynamically, which increases system, flexibility and provides conditions enabling LISP microcompilation.

2.2 List-processor system architecture

Figure 2 shows each of the relevant parts.

2.2.1 Two busses (I-BUS and O-BUS). The system uses two 32-bit-wide busses to link all its parts. There is direct bi-directional transmission between the two busses for greater flexibility in data flow.

2.2.2 Hard stack. Capacity 4 kw, word length 32 bits, composed of 4 k x 4 bit RAMs, chip access time 45 ns [nanoseconds]. The stack space is divided into two halves, each having an independent stack: the A stack and the R stack. The main function of the A stack is to implement variable constraints. The R stack is used for partial variable access and calling field protection. Each stack has a stack top pointer and in-stack random access pointer. The hardware dynamically monitors the stack access pointer and generates an interrupt when overflow occurs

2.2.3 Load register. This is an important component which supports the tagged data format. It combines the data in the two busses and the microcommand words according to address, node type, data type, cdr code, and other segments. It forms the data into the required format in one shot. Its output can be transmitted to the busses or arithmetic unit, or pushed directly into the hard stack.

2.2.4 Arithmetic [logic] unit (ALU). There is a 32-bit arithmetic unit composed of bit slices. It has 16 internal registers for use as pointers in chained-list processing and so on. It has arithmetic, logical, and various types of shift operation functions.

2.2.5 Matching circuit. This includes a 32-bit comparator which can segment and match up constants in the data and microcommands on the two busses. It accelerates data type detection and creates the conditions for transferring microprogram control. Its output is one part of the status word.

2.2.6 Microprogram controller. The microcommand word length is 80 bits, divided into four types: for memory operations, transmission operations, hard stack operations, and arithmetic unit operations. It has a total of 24 microfields and uses a mainly horizontal mixed decoding format. LISP-M1 uses a microprogram for direct interpretation of the LISP language, so microprogram controller efficiency is rather high, but it also is a rather complex component. It contains the following parts:
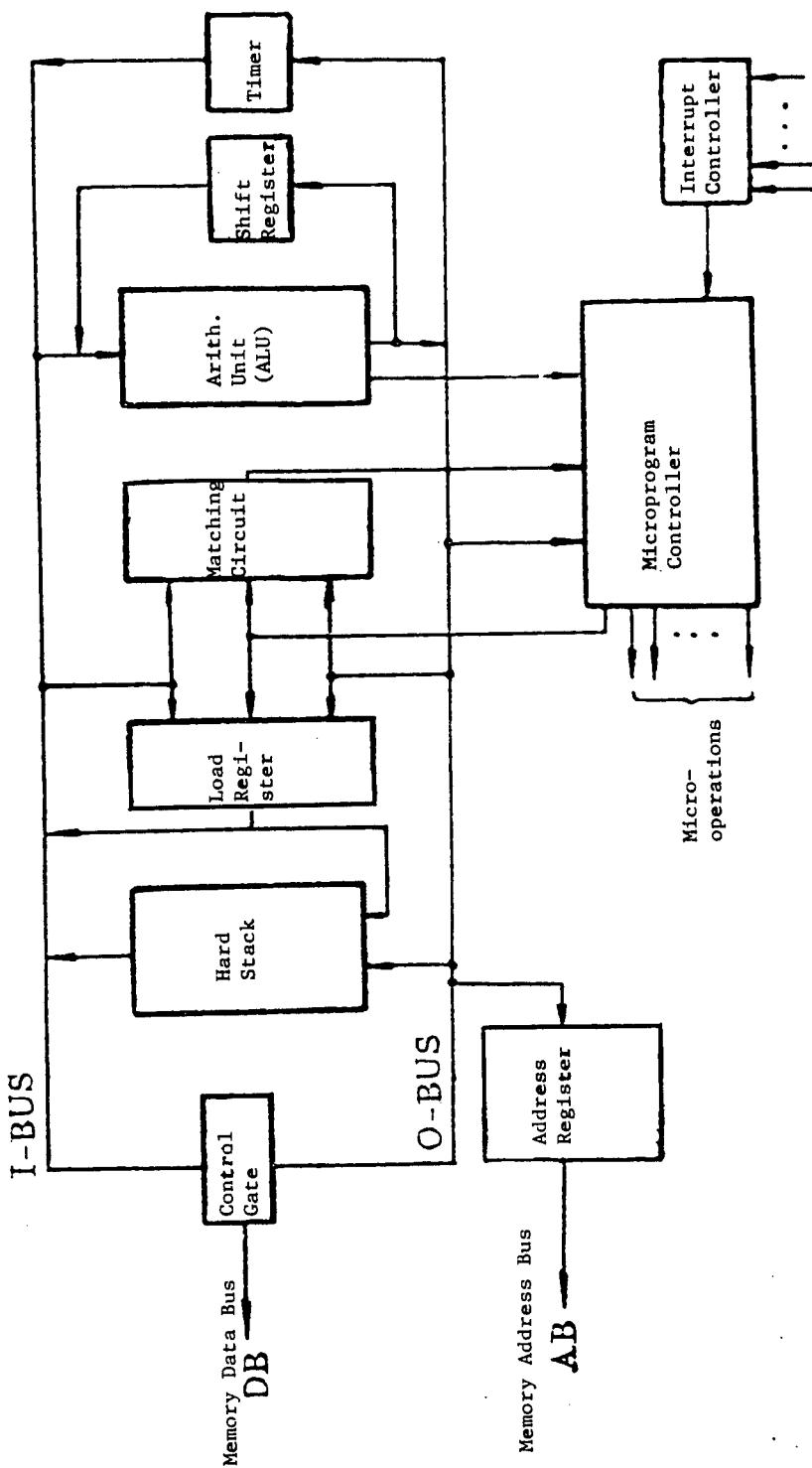
Figure 2.   System Architecture of List Processor LP

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a. Sequencer: Composed of bit slices, addressing space 64 k; supports asynchronous operations, with a variable cycle (160 ns to 240 ns);

b. Control stack: Capacity 4 k, supports microprogram multirecursive calls, has a speed which can ensure return address access within one microcycle;

c. Field-extraction circuit;

d. Next-lower-address formation circuit;

e. Microprogram memory: Word length 80 bits, capacity 16 k (expandable to 64 k); uses RAM techniques, access time 45 ns, loaded into the microprogram during initialization.

f. Microcommand register and decoding circuit: Uses one-stage microcommand pre-selection and partial microcode pre-interpretation techniques to shorten delay times in key paths.

2.2.7 Interrupt controller. Supports eight interrupt levels (vector interrupts); main interrupt sources are hardware breakdowns, mainframe communication, etc.

2.2.8 Interfaces. Data transfer between the list processor and the list memory uses an asynchronous answer-back pattern, whereas communication between the list processor and the mainframe is via mailboxes in the list memory and interrupt signals.

2.3 The chained-list processing format is an important factor which determines list-processor efficiency.

Two measures were adopted to reduce actual system execution time and increase effective use of space in the LISP-M1 list processor.

2.3.1 Cdr code is used to reduce the space occupied by list nodes. The basic unit of chained-list architecture is the cons (list node). Each cons unit also is divided into car and cdr components, with each usually occupying on memory unit. Normally, most of the car portion serves as pointers to the next unit. If most cons units are stored in sequence in adjacent memory units, and if the cdr code portion of the tag field of the car units serves as a declaration tag, then the cdr portions of these cons units can be eliminated. Moreover, if pointers in the cdr units usually point to the constant nil, additional declaration via cdr codes in the car portion also can eliminate these cdr units. Only in extremely few situations is it necessary to write out the pointers in the cdr portion. Thus, most list-node cdr can be eliminated by using the cdr codes of the car portion to represent these different situations. This reduces the space consumed by the chained-list architecture by one-half (or slightly less).

2.3.2 A node copying method used for garbage collection reduces collection time. The node copying method divides all of the list node space into two parts, a usable part and a copying part. The usable part is available only during system operation. When all of the space in the usable part is full, all useful list nodes in it are copied into the copying part. When copying is completed, the usable part naturally contains only useless nodes. Then, part of it is demarcated for a new copying part and the remainder becomes a new usable part. This uses the list node space in a cycled manner. Its advantages are:

a. Only useful units must be tracked during the garbage collection process, and there is no need to be concerned with useless units, which greatly speeds up the collection process;

b. The collected usable space is continuous;

c. Node units which originally were not adjacent during copying can become nearby stored units, further reducing the space occupied.

The microprogram-controlled tagged system architecture adopted in the list processor achieves parallel implementation of tag differentiation and list node processing, and thereby increases processing efficiency.

Assuming that the average proportion of non-adjacent list nodes among list nodes is p and that the proportion of the copying part in the list node space as a part of total space is m, the usable part proportion naturally is (1-m). When this pattern is compared with the conventional list node expression formula and the garbage collection tag method under conditions of similar memory space, the percentage increase in the number of list nodes in this method compared with conventional patterns and tag methods is

$$\Delta S = \frac{(1-2m)-p}{1+p} \times 100 \text{ percent}$$

If the number of list nodes is increased, then the following pattern must be satisfied

$$m \leq \frac{1-p}{2} \text{ or } p \leq 1 - 2m$$

Under usual conditions, this requirement is easily met. Generally, p < 0.1 and m < 0.25, and the number of list nodes which can be held can be over 30 percent higher.

Under similar list node count conditions, the average speed of processing list nodes in this method is V times the conventional pattern.

$$V = \frac{2}{1 + p}$$

Generally, p < 0.1, so V > 1.8.

Moreover, under similar list node count conditions, the percentage reduction in garbage collection time in this method compared with the original tag method time is

$$T = m(1 + p) \times 100 \text{ percent}$$

Generally, p < 0.1 and m < 0.25, so the garbage collection time is reduced by under 27.5 percent compared to the tag method.

III. List Memory

The LISP-M1 list memory is a large-capacity, high-speed random memory which also meets list processing and LISP interpretation system requirements. There are some peculiarities in its system architecture.

3.1. Hardware structure. Includes the following parts:

3.1.1 Memory. It is composed of dynamic memory arrays, currently uses 256 k x 1 RAM chips, has a data width of 32 bits, with 7-bit Hamming error checking and correction. A modular architecture is used in the memory, with each module containing 4 MB and the related error-correction circuits. The system usually contains four modules and can be expanded to a maximum of 16 modules (64 MB).

3.1.2 Dynamic memory controller. This controls memory access and refreshing. Refreshing is done using a distributed line refreshing method.

3.1.3 Advanced read-out data register. The main memory has three levels of advanced read-out functions. After the memory receives the address A, besides reading the content of A, it also can read the contents of (A) and A+1 in sequence according to the input command. These three partial read-out contents and the content waiting to be written in are stored in four registers.

3.1.4 Address adder. A high-speed adder is matched to advanced read-out and list-node processing.

3.1.5 Memory control components.

3.1.6 Data matching components and interfaces.

3.2 Memory system. Besides the usual addressable access functions, the list memory of the LISP-M1 system also has an advance read access function. After each address A is sent to the memory control component, it can select the content of A and select the content of (A) and (A+1) in advance according to the received command. As another command is received, it also uses (A) or A+1 as a new address A', reads the content of A' and then selects the content of (A') and A'+1 in advance. Then, the content of (A') or A'+1 becomes the new address A", continuing in sequence. Thus, if a chained-list initial address is provided from the outside, it can search along (A) or A+1 according to input command and does not need to retransmit another address. This transforms the linear memory space into dual-branch tree or cons space, simplifying access measures and forming a chained-list access process-type memory system [4].

To truly derive the benefits of this type of memory system, it must be configured with a list processor. The use of cdr code techniques in the LISP-M1 list processor matches exactly with advance memory read-out. In addition, a high-speed hard stack in the list processor serves as an information buffer and reduces the number of memory inquiries, thereby providing the list processor with sufficient time for advance read-out. As soon as the processor requires data, it has already been prepared in the list memory's data register. With the mutual matchup of microprogram, list processor, and list memory, the entire system can attain a relatively high processing speed.

IV. Evaluation of System Performance

In the area of system performance evaluation, operating results with benchmark programs can be used to evaluate existing operating systems or for simulated evaluation of existing design systems, but both involve certain costs. In actual use, the performance/cost ratio (PCR) of systems with similar functions can be used for a preliminary estimate of performance. We define the PCR as

$$PCR = \frac{M \times P}{C}$$

In the formula, M is memory capacity (in MB), C is the system cost or price (in 10,000 yuan), and P is operating speed (in klips or kcdr/s). In LISP systems, the period from the time of a call for cdr functions until a result is obtained is called for cdr time, and the inverse of the cdr time is the number of cdr executed per second (cdr/s). When using the number of logical inference steps per second (lips) to evaluate or compare speeds of LISP systems, cdr/s usually serve as lips.

The list memory capacity of the LISP-M1 system is B MB and the rough cost of the system is about 120,000 yuan. Fewer than 50 microcommands are used during execution of cdr functions, with an average cycle of 200 ns, equivalent to 100 kcdr/s, so

$$PCR = 67$$

For GCLISP interpretation systems in PC/XT computers, M = 0.50, C = 2.0, and the measured operating speed is less than 2.0, so PCR = 0.50. Comparing the two, the increase in the LISP-M1 PCR is 134-fold or about two numerical grades. Although a true performance evaluation should be based on results of executing benchmark programs in actual systems, the above analysis makes it apparent that the LISP-M1 system effectively increases the PCR.

V. Conclusion

The intelligent computer LISP-M1 system is a LISP computer which implements COMMON LISP expanded subsets. It has a functionally distributed multiprocessor system architecture, which gives the list processor a simple and effective architecture and also makes full use of the main processor's supporting role in an input, output, and software-tool environment. Tagged system architecture, high-speed hard stack, and microprogram-control technology are used in the list processor. The chained-list processing pattern uses cdr code to reduce space and a node copying method for garbage collection. The main memory has an advance read-out function. The combined implementation of these technologies makes the system highly efficient when processing LISP programs, and preliminary analysis indicates that its PCR is two numerical grades higher.

References

1. G. L. Steel Jr. et al., Common LISP: The Language, Digital Press, 1984.

2. K. Hwang, et al., Computer Architectures for Artificial Intelligence Processing, COMPUTER, No 1, 1987 pp 19-27.

3. Jia Biao [6328 1753] and Zheng Shouqi [6774 1343 3217], Research on Available Time of Expanded Interpretation Systems in Microcomputers, XI'AN JIAOTONG DAXUE XUEBAO [JOURNAL OF XI'AN JIAOTONG UNIVERSITY] Vol 21, No 3, 1987 pp 53-58.

4. Zheng Shouqi, System Architecture in Information Storage Systems, ZHONGGUO JISUANJI XUEHUI DIWUJIE XINXI CUNCHU JISHU XUEHUI XUESHU NIANHUI LUNWEN [ARTICLES FROM THE FIFTH ANNUAL SYMPOSIUM OF THE INFORMATION STORAGE TECHNOLOGY ASSOCIATION OF THE CHINA COMPUTER SOCIETY], 1986 p 40.

Real-Time Parallel Scheduling Strategy for Radar Data

[Article by Lu Lina [7120 7787 1226] of Xi'an Jiaotong University and Ye Hong [0673 1347] of the Ministry of Aeronautics Industry's Institute 631, Xi'an: "A Real-Time Parallel Scheduling Strategy"; manuscript received 21 Apr 87]

[Excerpts] Abstract

This article discusses parallel partitioning algorithms and parallel processing questions in a multiprocessor environment. It introduces two real-time parallel scheduling strategies, a single-stage non-tested algorithm and a multistage nested algorithm, and describes a formula for estimating the minimum number of processors required for processing work P within the least amount of time to serve as applied examples for the algorithms. Finally, the article introduces the use of multistage nested algorithms in radar data processing and solves key problems in using tightly coupled multiple microprocessor systems for parallel scheduling of real-time tasks in real-time systems, with satisfying results.

Key words: Real-time control, parallel processing, real-time systems

0. Introduction

In MIMD [multiple instruction stream/multiple data stream] multiprocessor systems (MPS), selection of the number of processing elements PE and questions of parallel scheduling are key factors which determine the performance/cost ratio of the MPS. This is particularly true in real-time multiprocessor systems, where selection of the PE number not only affects system performance but also seriously affects the complexity of real-time scheduling algorithms. We started with a task dependence graphic (TDG) and proposed a formula for estimating the number of PEs required in the MPS. There are two problems involved in

parallel scheduling: parallel partitioning and parallel scheduling of tasks. Parallel partitioning of tasks refers to compiling a parallel task graphic based on task interrelationships in the TDG graphic and the cost expended on each of the tasks using a certain number of processors. The quality of this work determines the efficiency of the scheduling algorithm. Parallel task scheduling is a dynamic process in MPS work which determines the sequence of task execution. This article introduces single-stage non-nested and multistage nested real-time scheduling strategies.

In a parallel scheduling algorithm, establishment of an n number of M/M/i ($1 \le i \le n$) queues for each PE permits greater flexibility in real-time multistage scheduling. This is particularly true when there is a loss of real-time scheduling. The system can be reconfigured to assure continued work on high-priority first-stage queue tasks, hold off on low-priority first-stage tasks, and reduced system stages.

[Passage omitted]

II. Parallel Partitioning of Tasks

Task stage paralleling questions are very hard to structure using the above equally authorized TDG graphic, so we will describe a type of unequally authorized TDG graphic partitioning algorithm.

Definition 2: A Parallel Task Graphic (PTG) is the minimum-cost TDG graphic for completing each item of work given a certain number of processors. It can be described by the three-element formula PTG = {TDG, K, C_{MIN}}, where:

1. TDG is the task dependence graphic described in definition 1 [omitted].

2. K is a fixed number of processors.

3. C_{MIN} is the minimum cost expended on processor P.

A single-stage task dependence graphic includes n tasks, P = {P_1, P_2, ..., P_n}, with the cost expended for each task defined as the total system cost which must be expended for that task. Its amount determines the status of that task in P, and it is the foundation for parallel derivatives. The cost consumption matrix C is an n x n stage matrix in which $C_{ij} \neq 0$ represents the cost expended on task i at the time of startup of task j. $C_{ij} = 0$ represents the cost of task j not expended on task i. Using the method described in the previous section, a parallel task graphic (PTG) can be derived for K processors to process P within the least amount of time. An example of the algorithm is as follows:

For the TDG graphic shown in Figure 1 (a), the cost expended is the working time for each task. The cost consumption matrix is shown in Figure 1 (b). First, we derive the key tasks in Figure 1 (a). Because the earliest starting time for each task is

$E_t = \{0,1,1,1,8,8,8,9,11,11,1,13\}$, there is a group of key tasks $P_k = \{1,3,7,9,12\}$ in Figure 1 (a). Assuming two processors (K = 2) and a start time $P_S = \phi$ (P_S is the task inherited from step i −1), the zero task group derived from C is $P_a = \{1\}$, and the total costs of the i-th step is $w^{ti} = 1$.

Figure 1
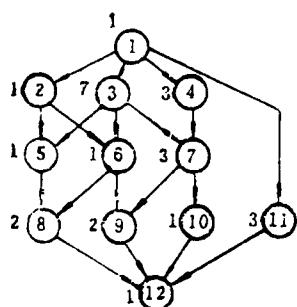
	1	2	3	4	5	6	7	8	9	10	11	12
1	0	1	1	1	0	0	0	0	0	0	1	0
2	0	0	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	7	7	7	0	0	0	0	0
4	0	0	0	0	0	0	3	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0
6	0	0	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	3	3	0	0
8	0	0	0	0	0	0	0	0	0	0	0	2
9	0	0	0	0	0	0	0	0	0	0	0	2
10	0	0	0	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	3
12	0	0	0	0	0	0	0	0	0	0	0	0

(a) Task dependence graphic   (b) Cost consumption matrix

This partitioning is suitable only for situations in which the cost consumption differential for each of the tasks is small, that is $|\omega_i - \omega_j| \leq M$ ($1 \leq i,\ j \leq n$), where M is a rather large number (graded threshold). For $|\omega_i - \omega_j| > M$, the multistage task parallel partition method is employed. Its algorithm is a group of tasks P divided into l groups of sub-task sets P^1, p^2, ..., p^l, to make $P \geq P^2 \geq P^3 ... \geq P^l$

so $P = \sum_{i=1}^{l} pi$. After doing the above partitioning for each p^i, multistage partitioning is carried out.

In real-time systems, each group of tasks must be completed within a specific time frame. It should have an earliest starting time of t_a, a task time limit of t_d, and a cycle $t_p = t_d - t_a$ for that group of tasks. Here t_s and t_e are, respectively, the actual task start time

and completion time[6]. Task groups with different time limits are partitioned into different task groups and processed in an alternating fashion in each stage's task system. Among them, they should satisfy the following inequality:

First stage:

$$t_e^{(1)} - t_s^{(1)} < t_p^{(1)}$$

Second stage:

$$t_e^{(2)} - t_s^{(2)} + \frac{t_p^{(2)}}{t_p^{(1)}}(t_e^{(1)} - t_s^{(1)}) < t_p^{(2)}$$

.

.

.

n-th stage:

$$t_e^{(n)} - t_s^{(n)} + \sum_{i=1}^{n-1} \frac{t_p^{(n)}}{t_p^{(i)}}(t_e^{(i)} - t_s^{(i)}) < t_p^{(n)}$$

In MPS, $t_e^{(i)} - t_s^{(i)}$ is the weighted value for i-stage key tasks, and each stage's tasks can be done independently. The consumption cost for each task $P_j^{(i)}$ for the i-th stage is $w_j^{(i)} = \frac{t_p^{(n)}}{t_p^{(i)}} T_j^{(i)}$, Here, $T_j^{(i)}$ represents the processing time for task $P_j^{(i)}$, and $t_p^{(n)}$ is the cost amplification rate, $\overline{t_p^{(i)}}$ which represents the number of operations for the i-stage task within time $t_p^{(n)}$.

III. Real-Time Scheduling Strategies

Theorem 2: The optimum tasks scheduling algorithm is the smallest average task response time derived from MPS[5].

3.1 Single-stage non-nested scheduling algorithms

Single-stage non-nested scheduling algorithms refer to the conversion of multistage real-time tasks into single stages for modular processing with a basic time period to achieve multistage non-nested parallel processing. For a given n-stage task, $p = \{p^{(1)}, p^{(2)}, \ldots, p^{(n)}\}$. Its cycle set is $T_p = \{T_p^{(1)}, T_p^{(2)}, \ldots, T_p^{(n)}\}$. Assuming that the minimum task cycle $T = \min \{T_p^{(j)}\}$ (for all values of j) is the system basic cycle, its corresponding task for that stage would be the basic task. The single-stage algorithm allocates the non-basic cycle tasks according to the time relationship in an average fashion to each basic

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cycle to assure balanced task loads for each basic cycle. If t_m represents the maximum operating time for K stage tasks, the cost expended to allocate K stage tasks to each basic cycle would be

$$w_{(K)} = T \cdot t_m(K)/T_p^{(k)}, \text{ so } \sum_{k=1}^{n-1} w_{(k)} \text{ is the total cost for allocating}$$

them to the basic cycles. In the scheduling algorithm, an M/M/i matrix is set up for each processor to show which task the processor should perform at that instant in time.

This algorithm is suitable for static real-time parallel processing, and is particularly suited to special-purpose real-time control systems. It does not, however, have a stage-reduction processing capability or a self-restoration capability in the event of a breakdown.

3.2 Multistage nested scheduling algorithm

This algorithm assumes that the minimum cycle for tasks at each stage is the basic cycle of the algorithm. When each basic cycle begins, it executes a "stage selection module" task to examine system working conditions, prepare parameters for the tasks of each stage, and decide upon the next step of work.

For each processor, n tasks matrices M/M/1, ..., M/M/n are established. They represent, respectively, the tasks to activate each stage that all allocated to each of the processors. The n matrices of the processor have a definite priority relationship.

In multistage real-time tasks, the cost expended for each of the tasks

is $w_j^{(i)} = \dfrac{t_p^{(n)}}{t_p^{(i)}} T_j^{(i)}$. The multistage task relationships of the real-

time tasks are shown in Figure 2 (a). $P^{(i)}$ is the interrelationship graphic for the i-th stage task, and is also a TDG graphic. Under

conditions of satisfying $\sum_{i=1}^{j} \dfrac{t_p^{(j)}}{t_p^{(i)}} \cdot \sum_{k-1}^{n} w_k < t_p^{(j)}$ for the tasks of each

stage, multistage task parallel partitioning is carried out. The memory architecture of the multistage parallel graphic is shown in Figure 2 (b).

The multistage nested scheduling algorithm increases the resource utilization rate and makes real-time scheduling more flexible, facilitating the achievement of stage reduction and self-restoration capabilities. However, a system to implement this algorithm would be more expensive. Most real-time MPS use a similar algorithm.
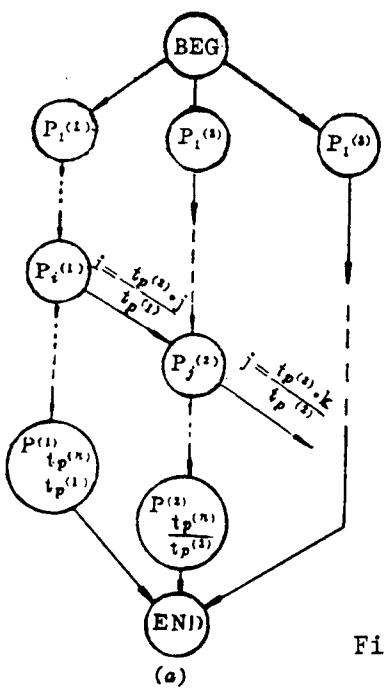
Fig 2 (a) Multistage Task Dependence Graphic
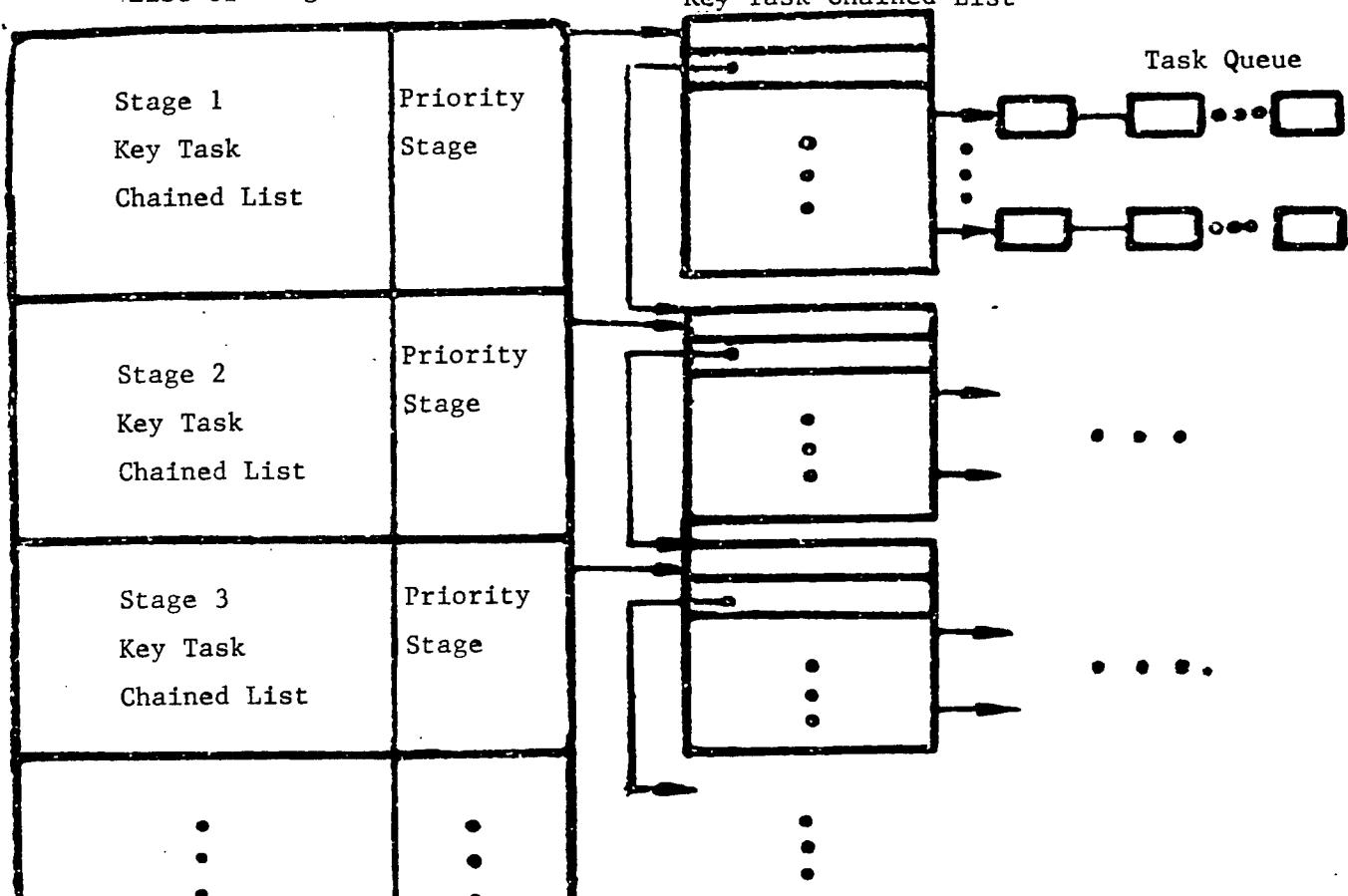
Fig 2 (b) Multistage Parallel Graphic Memory Architecture

IV. Radar Data Processing Systems

The radar data processing system is a special purpose real-time collection/control multi-microprocessor system. It is composed of five processors, including one central processor, three task processors (slaves), and one I/O central processor. The main processor is responsible for real-time control and communications for the entire system, the slaves are responsible for parallel computation of applied tasks, and the I/O processor is used for data collection. This system works mostly in an asynchronous fashion. The system architecture is shown in Figure 3.
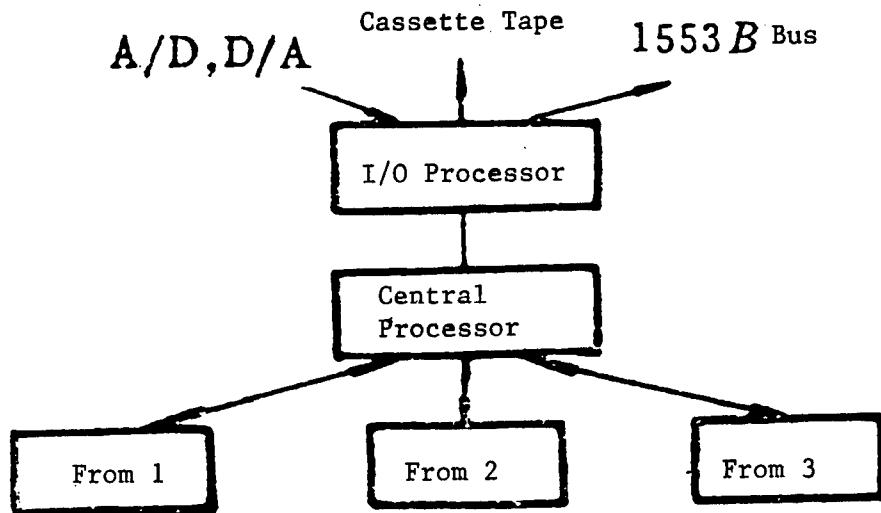
Figure 3. Radar Data Processing System

The tasks of the radar data processing system are divided into three stages, the task time cycles of each stage being 5 ms, 50 ms, and 1 s, respectively, with 5 ms being the basic cycle of this system. The first-stage tasks mainly involve 5 ms data acquisition/transmission, inertial navigation data processing, and radar data computations. They serve the radar servo system. The second-stage tasks mainly involve 50 ms data acquisition, editing, and tape recording for post-event analysis. The third-stage tasks mainly involve data transmission for real-time display in the radar system. Because of different external conditions, there are a total of seven stages in the radar system, with different tasks for each state. Thus, seven task models must be established.

This system uses a multistage nested parallel scheduling algorithm. A module table is set up to indicate all task paths which should be activated at any particular instant, to point to a grade differentiation table for the currently activated tasks, and to provide a task block table which prepares parameters for mainframe startup tasks. The various task working states are shown in Figure 4 (a), and the memory architecture for the parallel tasks is shown in Figure 4 (b).

Timing State

Conditions
Not Met

Up to Instant
of Execution

Transfer
State

Timing
State

Activated

Ready

Hanging

Execution

Execution Complete
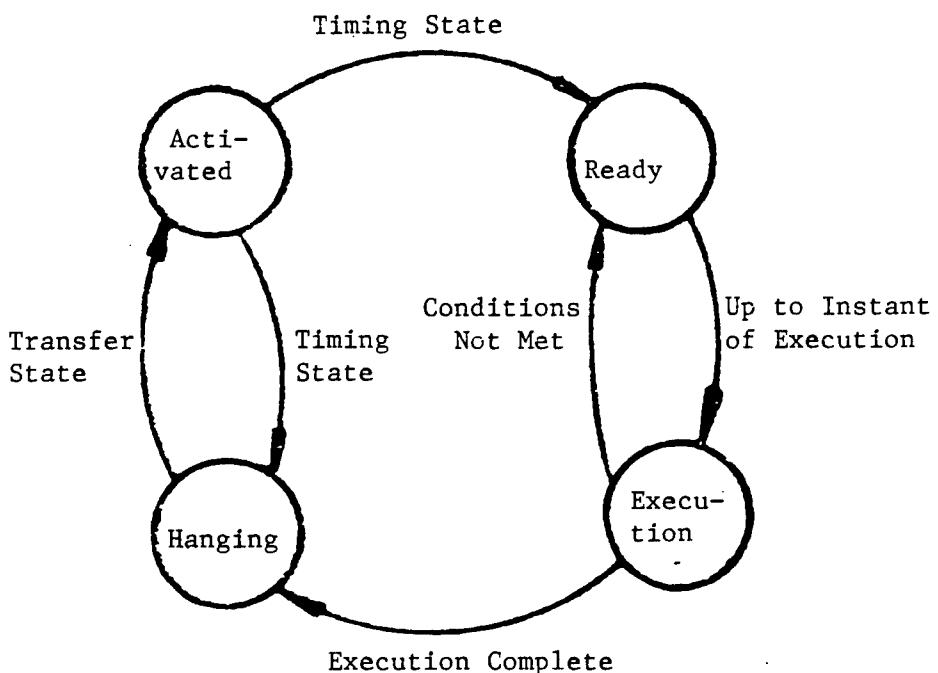
Figure 4 (a)   Task Working States

Activated Bit	Total Cost W^{ti}
i + 1 Stage Key Task Chained List	
P_{imax} Information Table Pointer	
Bearing Key Task Tag	Group 1 Task Queue
	Group 2 Task Queue
⋮	⋮
	Group K-1 Task Queue
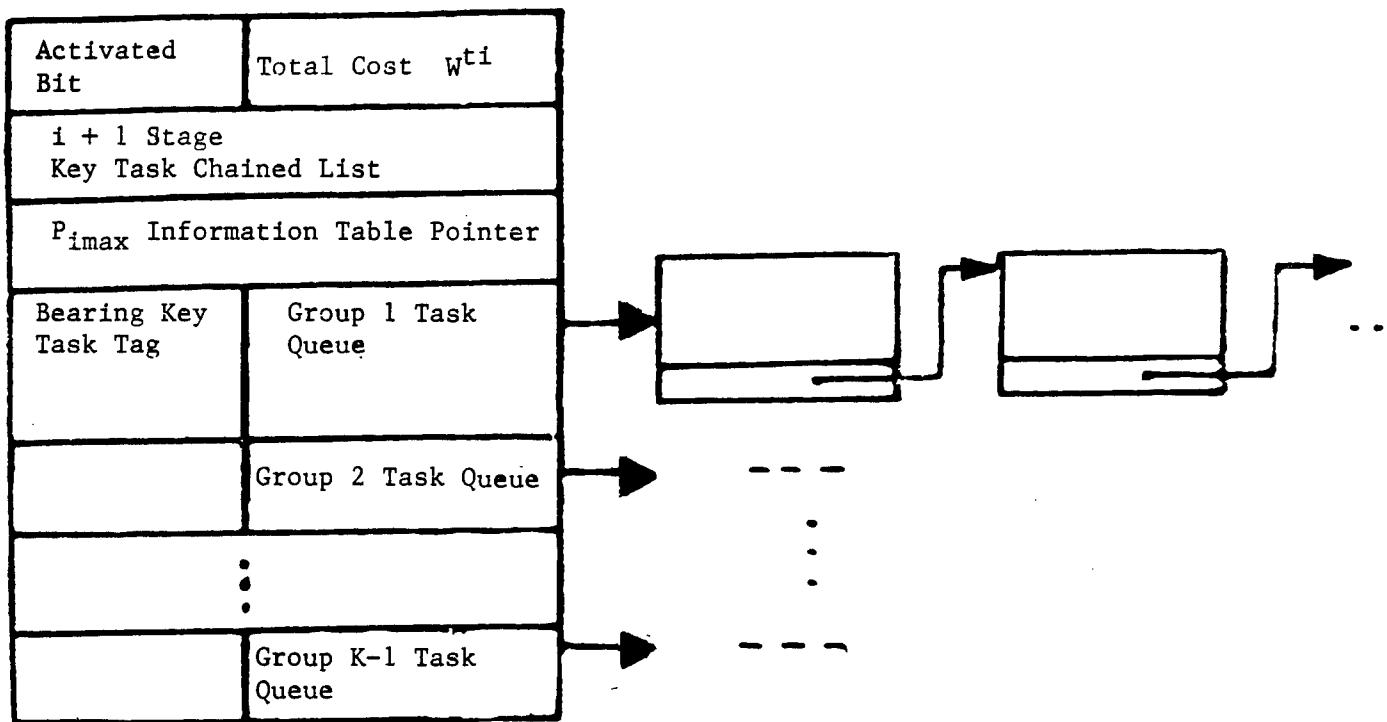
Figure 4 (b)   Radar System Parallel Task Memory Architecture

Like the system, the task architecture of the data input/output I/O processor consists of three stage tasks, with each stage task containing real-time collection of initial data and real-time transmission of data on results. Thus, the operating pattern of the I/O process is a multistage nested pattern in a single processor. The time sequence relationship between the I/O process within the basic cycle and the system operation is as follows:

Main-frame	Sampling from I/O	Stage 1 task operations	Stage 1 transmitted to I/O	Stage 2 or 3 operations	Or transmission of stage 2 and 3 results
I/O device	Transmission to mainframe	Stage 1 acquisition	Stage 1 results received from mainframe	Stage 2 or 3 acquisition	Stage 2 or 3 results transmitted to outside

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V. Conclusion

This article discussed derivation of the minimum number of processors required for real-time task parallel partitioning and scheduling in a multiprocessor system for processing work P within the minimum possible time. The starting point for both is to locate several groups of key tasks from the task relationship graphic and implement real-time parallel partitioning and scheduling which assures the processing of key tasks on schedule. This method can be used in distributed systems and in computer network systems, and it can be used in multiprocessor systems with different topological architectures merely by appropriately defining expended costs. Finally, we would like to express our gratitude to comrades Wu Wenying [0702 2429 5391] and Chen Minxiao [7115 3046 2699] for their assistance.

References

1. David J. Kuck, THE STRUCTURE OF COMPUTERS AND COMPUTATION, Vol 1, John Wiley & Sons, 1978.

2. D. J. Kuck, A Survey of Parallel Machine Organization and Programming, COMPUTING SURVEYS, Vol 9, No 1, March 1977 pp 29-39.

3. D. J. Kuck, Parallel Processor Architecture--A Survey, PROCEEDINGS OF THE 1975 SAGAMORE COMPUTER CONFERENCE ON PARALLEL PROCESSING pp 15-39.

4. C. V. Ramamoorthy, K. M. Chandy, and M. J. Gonzalez, Optimal Scheduling Strategies in a Multiprocessor System, IEEE TRANSACTIONS ON COMPUTERS, Vol C-21, No 2, February 1972 pp 137-146.

5. L. M. Ni and Kai Hwang, Optimal Load Balancing in a Multiple Processor System with Many Job Classes, IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, Vol SE-11, No 5, May 1985.

6. J. W. Jordan, Task Scheduling for a Real-Time Multiprocessor, NASA TN D-5786.

7. Jin Lan [6855 5695] et al., BINGXING CHULI JISUANJI JIEGOU [PARALLEL PROCESSING COMPUTER ARCHITECTURE].

Programmable Logic Array Testing Software Announced

40080096a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 46,
30 Nov 88 p 14

[Article: "CAS Computer Institute Presents PLAT, a Programmable Logic
Array Testing Software Package"]

[Text] The Institute of Computing Technology of the Chinese Academy of
Sciences (CAS) recently presented the programmable logic array testing
software package PLAT, which they hope will sell in world markets.

Programmable logic arrays (PLA) act as standard components or as ASIC [appli-
cation specific IC] circuits, and are being broadly applied, with a good
future. This software package (PLAT) includes six functions: design for
logical simulation, fault simulation, test products, and easy test generated
PLA, as well as design for strong fault protection for PLA, and design of
completely self-testing checking devices.

When comparing the design of easy test generated PLA (ETG PLA) with the
design of traditional PLA testable designs (EFT PLA), the hardware overhead
for this package is less by 2-4 times, there is less effect on circuit
performance, and the calculation complexity for test generation is $0(n)$
(where n is the product). Totally self-checking PLA (TSC PLA) designed
with PLAT only requires very few output code words in order to self-test
checking devices; this uniquely resolves a common and long-standing problem
in checking-device design. By using this software, test generation uses
the product-oriented linear method, which is advantageous for improving the
effects of test generation, and can as well generate test groups where faults
have been measured at a rate of 100 percent, by which one can discover all
cross-point faults that may not otherwise be examined. PLAT uses software
engineering and structured programming methods, documentation is complete,
there is a user-friendly interface, it is portable, and it can be easily
maintained.

Because PLAT has a full set of functions and is unique, is quite remarkable
for its ETG PLA and TSC PLA design, and meets international standards,
experts have considered that this software should be further commercialized
in its degree of application so that it might be marketed worldwide as
quickly as possible.

Official Stresses Importance of Chinese Computer Industry

40080096c Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 47, 7 Dec 88 pp 1, 3

[Article by Li Ye [2621, 8518], Director, the Computer Department of the Ministry of Machine-Building and Electronics Industry: "Promoting New Growth for China's Computer Industry"]

[Excerpts] The Ministry of Machine-Building and Electronics Industry is holding a nationwide conference on computer and software efforts 8-11 December. This is the first time since the creation of this ministry that a study conference on computer policymaking has been held, and it expresses the concern and respect of ministry leaders for computer efforts. The conference will sum up the experience and lessons of China's computer industry over 33 years, but even more importantly will open wide-ranging exploratory talks on such overall problems as the situation, goals, points of focus, developmental models, and relevant policies and measures facing the growth of China's computer industry. The meeting will also make arrangements for work and tasking for the years 1989 and 1990.

As the conference is about to convene, it is my intention to use this opportunity to discuss two problems.

I. The recognition of and reflections on China's computer industry.

[passage omitted]

II. Developmental principles and tasking for China's computer industry in the near-term.

We propose the principles of "intensifying the restructuring, managing the environment, dealing with applications, and allowing exports to lead" as we expand our efforts in order that China's computer industry can enter a benign economic-technological cycle as soon as possible. The last two years of the "Seventh 5-Year Plan" and the period of the "Eighth 5-Year Plan" will have fundamentally constructed a computer industry that will be benefitting from certain economies of scale, and to this end our primary mission is:

A. to bring everything together by way of restructuring, to continue intensifying the restructuring of internal mechanisms, to adjust industrial structures, and to build various types of new computer enterprises.

Computers are part of science and high technology, and both in China and abroad competition is fierce, markets change in all sorts of ways, technology is growing rapidly, and computer enterprises must be able to respond quickly. They must set up flexible, entirely new mechanisms in accordance with market demand. The fundamental way of progress for the computer enterprises is to change obsolete conservative concepts and methods, and to restructure old systems inappropriate to the demands of new situations.

The production structures of the computer industry are composed of three parts: state-run medium-to-large-size enterprises, small (township and private) enterprises, and enterprises funded through the "three ways." The medium to large enterprises are the backbone of the computer industry, and they should make strong efforts to absorb the experiences of the township and small enterprises, should constantly improve internal mechanisms, should break up the "three irons" (iron armchair, iron rice bowl, and iron wages), should smooth associations with labor, and should make the most of consortium companies. Small-scale enterprises should utilize their advantages, should always develop and manufacture "demand item" products, should enhance their lateral associations, and should grow toward economies of scale. We should also put much effort into developing "three-ways"-funded enterprises, and especially joint ventures. We must actively create the conditions by which to attract foreign funding, and to bring in advanced foreign technology and management experience. We should see those "three way"-funded enterprises as an important component of our industry.

B. We should continue to implement the "Taiji" Plan. We should continue to apply the strategic principles from the Shidao conference regarding the growth of China's computer industry, where the "Taiji" Plan is to build a computer industry featuring microcomputers, minicomputers, software, and complementary peripherals, and that is based upon fourth-generation computer technology. This is also the guiding thought for the "Eighth 5-Year" Plan.

The goal of this construction are to make breakthroughs in the design of automated technology for computers, system engineering technology, production techniques and software engineering technologies, to build up to economies of scale, and to greatly improve the market share for domestically produced computers.

C. Allowing "exports to lead" will quicken the development of the coastal-region export production base.

The computer industry will more quickly develop into an export-oriented economy, actively participating in international exchanges, and will enter world markets. Through exports, we can bring in advanced foreign production and management technologies and earn foreign currencies. In recent years, the coastal region (primarily, the Zhujiang delta, the Changjiang delta, and Bohai Bay) has begun to constitute an export processing and production area, and on this basis we should actively broaden associations of various types with foreign factories and commercial interests (including our own Taiwan among these). We should make use of the rise in value of foreign currencies--those opportunities where the costs of labor are rising. Over the past 2 years, using OEM (commissioned manufacture) as a point of breakthrough, we have improved the value of exports 1000 percent from 45 million US dollars in 1987 to 450 million US dollars.

D. Supporting the development of products that combine the mechanical with the electronic is a major technological direction for the computer industry. The integration of machinery with electronic technology is a significant trend, and the creation of the Ministry of Machine-Building and Electronics Industry has created conditions beneficial to promoting the unification of machinery and electronics. It will strive to develop products that integrate these two worlds, which will serve the transformation of traditional industry, and is a major mission for the computer industry. A council meeting of the ministry resolved that: we are to develop our efforts in accordance with the principle of "disseminating by batches, putting into production by batches, developing in batches, and taking command by batches." The focus for the past 2 years has been: numerically-controlled (NC) machine tools, new industrial control systems, electric-powered and electronic products, and products of computer applications (as for example CAD work stations).

E. In the spirit of "manage, rectify, and restructure" from the 3d Plenary Session of the Central Committee, the computer industry must also manage the economic environment and rectify economic priorities. The evidence of confusion currently present in the computer marketplace should gain our full attention, and some units have taken up the slogan "accumulate capital," have engaged in smuggling, are counterfeiting items, and are keeping or dodging taxes; this even includes some state-run enterprises that have resold and falsified imported goods. This not only disrupts markets and harms customers, but also confuses the thinking of our people, and it has seriously harmed the healthy growth of our computer industry. We must take strong measures and immediately take control of and rectify the economic priorities of the computer marketplace. We must join with industrial and commercial management departments in their investigations. We must be resolute in attacking and dealing sternly with profiteering of any degree to drive these people out of business, which will establish a good market environment for the growth of the computer industry.

F. We must vigorously develop the software industry. With the constant broadening of applications for computers, the proportion of software within the entire system will grow larger, eventually becoming the core and leader for the system. It requires less investment than does hardware, and it is a technology- and knowledge-intensive industry. If we can utilize China's intellectual resources well, software can well become a point of breakthrough. We should vigorously develop software enterprises, put out even more products, and improve the proportion of software within the computer industry. To this end we should also take steps to establish and facilitate "software protection laws."

There are both favorable and ominous elements in the Chinese computer industry at present, and there are beneficial and harmful factors concurrently. If we can take hold of those beneficial factors, diligently study ways to deal with them, intensify the restructuring, and work very hard, the computer industry in China is certain to manifest a new aspect of vigorous growth.

Electronic Navigation Chart System Developed

40080094c Beijing RENMIN RIBAO in Chinese 19 Dec 88 p 3

[Article by Yu Minghai [0151 2494 3189] and Wang Jingbo [3769 2529 3134]: "Ocean-Going Ships Can Expect To Say 'Goodbye' to Paper Charts"]

[Text] An electronic navigation charting system that integrates ocean charting information, ship parameters, navigation positioning, sounding instruments, and other equipment, passed its technical evaluation recently in Beijing.

This system substitutes electronic ocean charting for ordinary paper ocean charts, and as the ship is underway, it can accurately find its position, automatically plot the planned navigation route and actual path, and can aid navigation through the viewing field. It can maintain the ship's path throughout within an ocean-chart "window," can maintain a particular range of viewing field around the ship, and can randomly display necessary parameters for the ship under sail. The system is easy to use, is highly automatic, and is fitted with several function keys; but when necessary, manual intervention is also possible. The hardware is designed to be inter-faced intelligently, and various navigation guidance, positioning, and depth-gauging equipment can be connected.

The experts agreed that this electronic navigation ocean-charting system developed by the Naval Marine Mapping Institute is a high-technology product that combines specialties such as modern mapping technology, microcomputer technology, electronic image-processing technology, and guidance positioning technology, and that this product meets contemporary international standards. Its dissemination and use will play an important role in the automation of marine navigation, battle command, production management, and systems for planning [oil and mineral] prospecting.

Regulations Drafted to Protect Software Developers

40100036a Beijing XINHUA in English 0804 GMT 25 Feb 89 [see also FBIS-CHI-89-036, 24 Feb 89, p 44]

[Text] Beijing, 25 Feb (XINHUA)--A draft of regulations to protect software developers has been finished and will be approved by the State Council, "CHINA DAILY" reported today. Computer software is a special industry that is hard to develop and easy to copy; developers' hard work will come to nothing if their interests cannot be protected, an official of the group in charge of drafting the law said Friday. Yang Ming, who is also a division chief of the China Software Technology Corporation, said that China has imported a large number of personal and microcomputers since the nation opened up to the outside world in 1979, but cases of copying software have often occurred.

The regulations will ban illegal copying, plagiarizing and selling the software invented by others, he said. Protection of computer software is in essence the protection of an "intellectual property right," he said. Our aim is not only to safeguard the developers' interests, but also to push science to develop, he said. Software alone can be protected by the copyright law, but it cannot be protected when it is combined with hardware.

China has not yet issued a copyright law, but a draft has been repeatedly discussed over the past 10 years. The law is expected to be submitted for approval this year by the National People's Congress, he said. China has received assistance from the International Business Machines Corporation (IBM) in drafting the law and the proposal presented by IBM has become a major source of information for the Chinese lawmakers, he said. Specialists have also collected information about software copyright protection from more than ten countries and regions and have made a number of studies.

Environmental Study Paints Grim Picture for Year 2000

40081017a Beijing RENMIN RIBAO in Chinese 3 Dec 88 p 3

[Text] The environmental issue is a global one. Today there is heavy
environmental pollution and ecological damage in China. As the economy
develops, what will the environmental situation in China be by the end of
the century? The "Environmental Forecast and Policy Recommendation Study
for China in the Year 2,000" which was appraised today, applied systems
engineering and the tenets of information theory to integrate the economy,
population, and environment into a macro-system to predict, confirm, and
describe the environmental prospects in the year 2000 for the country as a
whole and for each province, municipality and region, and propose appropriate
policies.

This research undertaking, in which over 1,000 people took part over a 4-year
period, predicts that, based upon current developmental trends, China's
environmental pollution will be even more serious by the end of this century.
If strong measures are adopted, the investment required to bring it under
control will be about 1 percent of the national income. By the year 2000,
the amount of waste water released will have increased from the 34.8 billion
tons released in 1985 to 49 billion tons, while the treatment rate will have
increased from 20 percent in 1985 to 53 percent. Release of particulate
pollutants into the atmosphere will have decreased from 5.18 million tons in
1985 to 1.9 million tons. Dust release will have increased from 18.83 million
tons to 24.17 million tons and sulfur dioxide release will rise from
13.03 million tons to 22 million tons. Acid rain will become more prevalent
and the total amount of solid waste released will exceed that released in
1985 by a factor of 1.3.

The "forecast study" indicates that irrational exploitation of natural
resources and constant deterioration of the ecological environment are more
serious environmental issues than China's pollution problem. If very effective
methods are not adopted to halt the daily expansion of damage to forests and
grasslands, soil and water loss, soil salinization and desertification, and if
we do not reverse the rapid loss of rare and endangered species, by the end of
this century the deterioration of China's ecological environment will continue
to the point of becoming a key factor in affecting and limiting socioeconomic
development.

The "forecast study" employed market value, opportunity cost and project cost methodologies in estimating the economic losses resulting from current environmental pollution and ecological damage. Economic losses resulting from pollution amount to 36 billion yuan per year. Of this total, air pollution accounts for 10.1 billion yuan, water pollution accounts for 15.7 billion yuan and agricultural chemical contamination accounts for 9.6 billion yuan. Ecological damage results in annual economic losses of 50 billion yuan. Of this total, 36.3 billion yuan is accounted for by damage to agricultural resources, damage to forest resources accounts for 11.5 billion yuan and damage to water resources accounts for 1.9 billion yuan.

The "forecast study" task was a huge systematic project of an interdisciplinary, interdepartmental and interregional nature. It analyzed the course of development of foreign and domestic environmental problems and environmental protection experience and proposed insistence on development characterized by harmony between the economy and the environment, reliance on scientific and technological progress, involving environmental protection in the course of the planned establishment of the economy, setting up an environmental development strategy characterized by restricted and rational exploitation of resources, the strengthening of environmental management, perfecting the legal system, making a major effort to raise the environmental consciousness of all the people and other strategic measures.

The appraisal committee, chaired by the well-known ecologist, Professor Ma Shijun, considered that this project, commissioned by the State Bureau of Environment Protection and undertaken by the Chinese Institute of Environmental Science, which organized the research subjects initiated by environmental protection departments nationwide, has provided an important basis for the confirmation of correct environmental protection strategies and objectives, and the formulation of environmental policies.

Fees To Be Imposed Upon Pollutant Discharge

40081017c Beijing RENMIN RIBAO in Chinese 25 Dec 88 p 3

[Text] The imposition of fees on the discharge of pollutants is a unique
system used by China to promote the prevention of pollution by industries
and businesses. It not only clarifies environmental responsibility, but it
also solves some of the funding problems for pollution clean-up. A great
many foreign friends have expressed intense interest in this system. They
consider it an innovation of China which provides an important precedent not
only for developing countries but for developed countries as well. This was
indicated at the State Bureau of Environmental Protection's working
conference on the imposition of pollutant discharge fees recently convened
in Beijing.

Implementation of a fee system for pollutant discharge was first proposed by
the Central Committee of the Chinese Communist Party in December 1978 in a
document ratified and passed on to the former State Council Environmental
Protection Leading Group. Afterwards, it passed through the Standing
Committee of the National People's Congress for legal confirmation. Ten
years of practical experience confirms that this mechanism, embodying
economic returns and established from the Law of Value, has opened up an
important new channel of funding. It is estimated that, as of the end of
1988, the 29 provinces, municipalities and autonomous regions which have
initiated this measure have collected a total of 7.65 billion yuan in
pollutant discharge fees from 180,000 enterprises and businesses that have
exceeded pollutant discharge quotas. This year, the total amount imposed
could reach about 1.6 billion yuan. This is an increase of 11 times over
the total collected during 1978 and 1979, the first two years of imple-
mentation. The amount of the fees collected which has been used to subsidize
pollution control by enterprises and business organizations has reached
4.8 billion yuan over 10 years. That used to subsidize regional-type
integrated remedies amounts to 360 million yuan. These funds, used as
pollution control subsidies, account for about 15 percent of the total
amount spent nationwide for pollution control, while in more developed
provinces and municipalities, generally this may reach 25 to 35 percent.

The levying of pollutant discharge fees is an important method in the strengthening of China's environmental supervision and management. Execution of this policy touches directly upon the profits of the enterprise and is advantageous in spurring managers in moving from a negative to a positive approach to pollution prevention. Not long ago the State Bureau of Environmental Protection investigated the effect that use of pollutant discharge fees has had on 3,901 organizations in 24 middle and large size cities nationwide. In 7 years these organizations invested 128.2 million yuan and completed 7,123 pollution control projects. Waste water treatment totaled 794 million tons per year, waste gas treatment totaled 199.1 billion cubic meters, the treatment and integrated use of solid waste totaled 34.5 billion tons and 986 sources of noise pollution were brought under control. Controlled and integrated use of resources yielded direct economic returns of 244 million yuan, allowing enterprises to negate their 96.18 million yuan in pollutant discharge fees and pollution incident reparations. Additionally, 183,000 people were removed from pollution danger.

As the pollutant discharge fee mechanism was carried out and perfected, China gradually formed a contingent devoted to the supervision and control of pollution which utilized the imposition of pollutant discharge fees as its primary method. At present, there are 658 monitoring and control organizations and about 7,000 personnel nationwide. In the past 10 years, the State has provided 120 million yuan from the pollutant discharge fees for the development of environmental control undertakings. Nationwide there are already 1,491 environmental monitoring stations of all levels and 22,000 monitoring personnel. The first steps have been taken in forming an atmospheric monitoring network centered on large and middle size cities and a water quality monitoring network centered on the water system and the oceans.

Director of the State Bureau of Environmental Protection Qu Geping pointed out at the conference that the gradually deepening reform of China's political and economic systems has raised some new problems for the levying of pollutant discharge fees. Further improvements must be made in each of the links in the collection, management and application of pollutant discharge fees. Enforcement must be strict and the fees levied without exception and in the full amount. Pollutant discharge fees should be drawn into the contract management of enterprises so as to improve the regulatory mechanism. The initiative of enterprises in the control of pollution must be mobilized to an even higher degree to make this system play an ever more effective role in raising the environmental protection work of China to a new level.

Study of Manganese Nodules From the Pacific Ocean

[Article by Yang Shengxiong [2799 0524 7160], Zhu Erqin [2612 5079 0530] (Ocean University of Qingdao, Hekou Coastal Region Research Institute); Chen Suitian [7115 4482 3944] (First Institute of Oceanography, State Oceanography Bureau)]

[Text] Abstract: This paper describes the results of research into the composition, texture and structure of north central Pacific manganese nodules. The nodules can be divided into rough and smooth types. The interior displays a concentric layered structure around a central core. The shell can be divided into several gross layers. Between these gross layers is nonconcordant or pseudoconcordant contact. The microlayers within the gross layers exhibit a rhythmic arrangement. After research into the characteristics of element and mineral component distribution in the gross layers and the rhythmic layers within the gross layers, the author considers there to be a relationship between the growth of the gross layers and interruptions or reductions in the deposition rate of sediments in the area in which the nodules were formed and the rhythmic character of the microlayers to have arisen from nodule growth during the process of rolling. The paper also contains a general discussion of the nodule growth process.

Deep ocean manganese nodules, because they are rich in Mn, Fe, Co, Ni, Cu, and other metallic elements, are increasingly the object of attention. A great deal of experimental research is emerging. Manganese nodules, particularly those of the smooth type with a characteristic concentric shell structure, can be used to explain the growth process of the manganese nodule.[1,2] In spite of this, due to dissimilarities in aggregation between different areas or different parts of the same area, many questions still exist.[3] The State Oceanographic Bureau survey ship "Xiangyanghong" number 16 carried out investigative research between May and July, 1983, of the north central Pacific Ocean area located from 7°N to 11°N and 165°W to 178°W. A large number of samples were gathered. The author first carried out compositional, textural and structural research on samples from three locations, M_{20}, M_{21}, and M_{15}. The geological conditions of these areas have already been reported.[4]

I. Shell Structure

The nodules exhibit agglomerate, cluster and linked-sphere shapes. From Table 1, it can be seen that M_{20} and M_{21} are smooth-type nodules while M_{15} is a rough-type nodule. Inside the nodule the concentric shells grow around the core. The core is composed of elongated, tabular or radially shaped volcanic glass, fragments and grains, bits of bone or fragments of old nodules. The shell is composed of compact grey and grey-white compact ferromanganese oxides, hydroxide and dark grey nonferrous manganese oxides. The shell is divided into gross layers and microlayers. Those veined-layer groups with identical or similar rhythm are termed "gross layers"[5,6] while the veined-layers are referred to as "microlayers." Moving outward from the interior, four gross layers with dissimilar structures can be delineated. The structure of each gross layer is divided into porphyritic, dense, lumpy and columnar (Table 2). Between the four gross layers, pseudoconcordant and nonconcordant contact is exhibited. The first gross layer (the innermost) also exhibits nonconcordant contact with the older nodule fragment, this indicates that the nodule growth process is not continuous. Each gross layer represents a relatively stable growth period, while the interruptions between layers indicate the washing and corrosion of the nodule. As far as shape is concerned, the second and fourth gross layers are comparatively similar and the microlayers are severely folded and undulated. The second gross layer exhibits pod-shape growth while that of the fourth gross layer is columnar, the column and growth direction are parallel and ramification occurs. The above phenomenon indicates that the micro-environment of the formation of second and fourth gross layers is comparatively turbulent and the exterior motion forces must be relatively strong.

Within the gross layers a series of microlayers exhibiting rhythmic arrangement can be seen. One rhythmic cycle (from interior toward exterior) is composed of three microlayers: 1) The base is a microlayer composed of non-continuous, nonferrous manganese material (a ferromanganese contaminated clay material). 2) A microlayer containing rancieite and δ-MnO_2. 3) A microlayer primarily composed of δ-MnO_2. The thickness of the entire rhythmic pattern is about 0.1 mm. The rhythmic pattern represents the continuous growth process of the structure.

II. Composition

In order to investigate the growth process of the gross layers and the rhythmic microlayers, electronic microprobe analysis was carried out on the nodules. A relatively pronounced inversely proportional relationship is exhibited by Mn and Fe while Mn and Ni exhibit a directly proportional relationship. Information from chemical analysis also shows this type of tendency. Table 3 lists the values for the electronic microprobe analysis of the ferromanganese oxides in the rhythmic layers of the nodules. After linear regression analysis carried out on these values, it became known that between Mn-Ni, Mn- (Ni+Cu) exists a better interrelationship. The major relational expressions are as follows:

$$Mn = 37.02-0.945Fe \qquad R^2 = 0.64$$
$$Mn = 21.32+4.63Ni \qquad R^2 = 0.643$$
$$Mn = 21.02+3.12(Ni+Cu) \qquad R^2 = 0.65$$

Table 1. Exterior Features of Manganese Nodules

Sample	M_{15}	M_{21}	M_{20}
Location	8°12.79'N, 170°31.67'W	12°12.19'N, 157°55.10'E	22°4.72'N, 157°58.43'E
Color	Brown-black	Black	Black
Luster	Metallic-semimetallic	Semimetallic	Semimetallic
Streak	Brown	Brown	Brown
Dry weight	24.12 grams	21.8 grams	11.33 grams
Net weight	26.28 grams	23.15 grams	12.05 grams
Size	4.4 x 3.5 cm^3	3.5 x 2.6 x 2.5 cm^3	3.8 x 2.0 x 1.8 cm^3
Shape	Grape-shaped	Agglomerate	Linked-sphere
Surface features	Upper surface exhibits micro-spherical grains Lower surface exhibits nodular, grape shape Nodule diameter 0.5-1.5 cm	Surface smooth of exhibits micro-spherical grains, developed fissure lines	Surface smooth or exhibits micro-spherical grains, developed fissure lines
Nodule type	Rough	Smooth	Smooth
Type of shape	$m[P]^s_{r-b}$	$m[P]s$	$m[P]s$

Table 2. Structure and Texture of M_{20} Smooth Nodule

Layer	Structure	Thickness (cm)	Texture
Core		Overall 10-15 diameter* Single 0.07-3 core	Old nodule fragments exhibit wavy annular texture
First gross layer	Porphyritic	0.4-1.3	Wavy annular texture
Second gross layer	Dense	3-4.5	Wavy annular texture, partial mosaic structure

Layer	Structure	Thickness (cm)	Texture
Third gross layer	Agglomerate	0.85-1.14	Laminated annular texture
Fourth gross layer	Columnar	2.5-3.5	Wavy annular textile

*Overall diameter includes multiple cores and the first gross layer.

Table 3. Percentages of Major Elements in Manganese Nodule Microlayers

number	Mn	Fe	Co	Ni	Cu	Mn/Fe
1	35.060	8.707	0.580	1.979	0.980	4.027
2	29.468	6.180	0.446	2.454	1.087	4.768
3	25.934	10.242	0.766	0.557	0.157	2.532
4	22.146	12.981	0.912	0.250	0.134	1.706
5	20.781	15.104	0.262	0.261	0.217	1.376
6	22.915	14.612	0.428	0.368	0.158	1.568
7	25.329	15.149	0.575	0.384	0.233	1.672
8	25.881	11.746	0.729	0.483	1.405	2.203
9	22.139	13.476	0.630	0.340	0.065	1.643
10	23.125	14.479	0.630	0.435	0.068	1.597
11	21,995	15.157	0.414	0.238	0.256	1.451
12	20.385	19.679	0.714	0.747	0.500	1.036
13	29.530	6.350	0.380	2.170	0.940	4.650
average	24.976	12.605	0.574	0.820	0.477	2.325

However, the interrelationship between (Ni+Cu), Co and Mn/Fe is more complex, in general limited to Mn/Fe = 2.5. Values for Mn/Fe ratio exceeding 2.5, i.e., when the Mn content exceeds the 25 percent point, correspond to micro-layers which are higher in rancieite and δ-MnO$_2$, at this time, Co decreases with the increase of Mn/Fe ratio, when Mn/Fe ratio is less than 2.5, i.e., Mn is less than 25 percent, it corresponds to δ-MnO$_2$ microlayers, at this time, Co and (Ni+Cu) also follow the increases in Mn and Fe. Some researchers consider rancieite's higher manganese content than δ-MnO$_2$ coincides with the results of this research. The changes in the value for the Mn/Fe ratio are caused by diverse growth environments. Halbach[8] (1987) considers Mn/Fe values less than 2.5 to represent hydrogenetic growth; Mn/Fe values of 2.5 to 5 to represent growth through migmatization and Mn/Fe values greater

than 5 to indicate early lithification. Therefore, the rhythmic microlayers of the samples from this region (M_{20}) also should embody the hydrogenetic and migmatization growth processes. The compositions of microlayers resulting from dissimilar growth processes are clearly different.

III. Discussion

It is apparent from the above information that the structure and texture of each gross layer in the shell of the smooth-type nodules is different. Dissimilarities in gross layer structure reflect the fact that relatively large changes existed in the formation environment. Compositional dissimilarities of the rhythmic microlayers contained in the gross layers arise from changes in the micro-environment during the nodule formation process. Therefore, through research on the gross layers and the rhythmic microlayers, the nodule formation process can be reconstructed.

1. Gross Layers

The characteristics and interelement relationships of the four basic gross layers existing in the nodules, reflect the discontinuity and environmental changes of the formation process. This author considers this to be related to interruptions in the deposit of sediment in this region or reductions in the rate of deposition. Wu Shiying[4] has used the isotope method to measure the growth rate of the outermost (number four) gross layer (2.5-3.5 mm thick) and has obtained a rate of 1.0-1.75 mm/Ma (1 million years). Based on the empirical formula: S (mm/Ma) = 13.79 (Mn/Fe^2)+0.75 and the results of electronic microprobe analysis, an average growth rate of 4.17 mm/Ma can be obtained. Given this, one gross layer must have a history of several hundred thousand years. This is in general agreement with the most recent (late previous epoch--present epoch) interruption in deposition. Thus, it can be deduced that the gross layer growth process is related to interruption of sedimentation or reductions in the rate of deposition.

2. Rhythmic Microlayers

Within the gross layer, the growth of the microlayers exhibit rhythmic changes. From the interior toward the exterior, in succession, are the clay microlayer, the rancieite $\delta-MnO_2$ microlayer (Mn/Fe = 2.5-5) grown through the migmatization effect, and the $\delta-MnO_2$ microlayer of hydrogenetic origin. Rhythmic microlayers constantly regrow in this fashion ending with the gross layer. Rhythmic formation is possibly produced by nodule rolling. In order for the nodule to remain at the surface of the sediment, frequent rolling or overturning is required. The time needed for a single roll is $(9.83-13.7) \times 10^4$ years. Based on growth rate calculations, this period is very close to the exact time required for one rhythmic growth. That the rhythm is the result of a rolling process, can also be deduced from compositional variations. In general, this process is as follows: During the beginning stage the core or nodule is exposed in the seawater and a side comes in contact with sea floor sediments through slow rolling. The bottom, through continuous rolling, becomes contaminated with sediment adhering to it, thereby, developing a clay microlayer which is not highly continuous. This clay microlayer is immersed

in ferromanganese material supplied by interstitial water. Continued rolling removes this side from the sediment surface. After a period of time the ferromanganese material in the clay microlayer will leach out, supplying manganese oxides for growth. Additionally, manganese oxides precipitate directly from seawater on the nodule surface. In this way, microlayers formed through migmatization and containing relatively large amounts of rancieite are created. With further rolling, microlayer growth primarily results from direct sedimentation of ferromanganese material, giving rise to microlayers of hydrogenetic origin.

References

[1] Dunham, A. C. and Glasby, G. P., Petrographic and eletron microprobe investigation of some deep and shallow water manganese nodules. N. Z. J. Geol. Geophys. 1974, 17: 929-953.

[2] "Marine Mineral Research" (Halbach, P. lecture material) Trends in Marine Geology, supplementary publication 1, 1987.

[3] "Manganese Nodules: Some Still Unanswered Questions," Marine Geology, translated collection, No 4, 1983.

[4] Wang Yongji, Han Shuqiao, Chen Suitian, "Comprehensive Research Report on Investigation of North Central Pacific Ocean Manganese Nodules." Ocean Publishers, 1986.

[5] Sorem, R. K. and Fewkes, R. H., Manganese nodules, IFI/Plenum Data Co., 1979.

[6] Zhu Erqin, "Minerology of Ocean Manganese Nodules," Shandong University Publishers, 1987.

[7] Dan Lianfang, "The Structure and Texture of Ocean Manganese Nodules," Marine Geology and Quaternary Period Geology, 1988, 8 (1): 67-72.

[8] Halbach, P. et al., Geochemical variation of ferro-manganese nodules and crusts from different province of the Pacific Ocean and their genetic control. Chem. Geol. 1981, 34 (1/2): 3-17.

First Nuclear Waste Sites Planned for Zhejiang, Northwest

40101011 Hong Kong SOUTH CHINA MORNING POST in English 20 Feb 89 pp 1, 2

[Report by Seth Faison in Beijing]

[Text] China plans to build its first permanent nuclear waste storage sites, one in the coastal province of Zhejiang and another in the northwest, an official newspaper reported yesterday.

Refuse from the Daya Bay nuclear power plant and the Qinshan plant near Shanghai, both scheduled to go into operation in the next few years, will be stored at the Zhejiang facility.

The proposed dumps, which will be lined with steel and placed five to 30 metres underground, will each occupy dozens of hectares, and were described by BUSINESS WEEKLY as China's first permanent nuclear waste storage sites.

China has been involved in nuclear production for over 25 years. While it is not known how waste from nuclear weapons has been stored during that time, radioactive waste from the country's 20-odd non-military nuclear production enterprises has to date been kept in the basements of concrete buildings, said Mr Pan Ziqiang, director of safety department in China's National Nuclear Industry Corporation.

The storage sites, which exist in half of China's 30 provinces, are useful for only 10 years, and Mr Pan said all waste currently stored in them will eventually be transferred to the permanent sites--an exercise which in the Zhejiang case, is expected to cost tens of millions of yuan.

Mr Pan acknowledged that there is public concern over the safety of nuclear waste disposal in China--where environmental protection is usually considered less important than cost.

Discussions were held last month between his corporation and Zhejiang officials, but he did not reveal their response. "The most important factor is public opinion and support from the local governments," Mr Pan was quoted as saying.

But he defended China's record on nuclear safety, saying he was unaware
of any "noticeable" nuclear pollution accidents, although minor ones have
occurred. Late last year, for example, 15 people were exposed to radiation
at a factory in Nanjing after a piece of uranium was "lost," the newspaper
said.

A law on the prevention of nuclear pollution is currently being drafted,
Mr Pan said, and will be added to the 32 existing laws and regulations on
safety in the nuclear industry.

Mr Qu Geping, director of the State Environmental Protection Bureau, said
there have been cases of "improper management of small quantities of medical
and industrial nuclear waste." But he maintained that China has not
experienced any radioactive spillage or contamination.

At Daya Bay, installation of the first of two 900 megawatt reactors will
begin in September, said Mr Liang Hanzhao, deputy manager of the Guangdong
Nuclear Power Company. He described construction at the site as "steady."

The Guangdong Government is also planning to build an additional station
next to the Daya Bay plant and two other nuclear power stations elsewhere
in the province.

At Qinshan, 30 million yuan (HK$63 million) has been allocated for prepara-
tory work in the second stage, where two 600 megawatt reactors are scheduled
for completion [in the mid-1990's]. The first stage, a 300 megawatt reactor,
is scheduled to go into operation next year.

Chinese officials have said they aim to earmark 80 percent of all new
nuclear enterprises for the production of civilian items such as nuclear
instruments, automatic fire alarms, building materials and other light
industrial products.

While coal still provides around 70 percent of China's energy needs, officials
are eager to expand their nuclear power capacity and are hoping to open
several more nuclear plants in the mid-1990s.

Feasibility studies on nuclear plants for Fujian, Shanghai, Hainan,
Liaoning and Heilongjiang have already begun.

China's main nuclear testing site is at Lop Nor in the Xinjiang Uygur
autonomous region in the far northwest, an area mainly made up of
uninhabited desert and mountains.

The northwest's Gobi Desert has been mentioned as a potential radioactive
waste dump site. In 1987, China and a West German company discussed a
proposal for China to store West German nuclear wastes in the Gobi Desert
in return for West German power plants.

Nothing came of the proposal, partly due to transportation problems.

BRIEFS

Antarctic Facility Beefed Up--The Scientific research icebreaker "Jidi," carrying China's east Antarctic investigation team departed from Qingdao harbor this morning for the Antarctic. During the present surge of interest in Antarctica. China will build Zhongshan station in Antarctica, representing another major step in China's investigation of that continent. This investigative team is composed of 116 people from 30 organizations of 13 departments, committees, and bureaus. Sixty of the members have participated in previous Antarctic investigations. Having arrived in east Antarctica's Prydz bay, and unloaded materials to complete the first phase of the Zhongshan station project, the "Jidi" will on 12 April 1989, depart for Qingdao. The project will last 144 days and the total distance of the journey will be 15,976.5 nautical miles. [Summary] [40081017b Shanghai JIEFANG RIBAO in Chinese 21 Nov 88 p 1]

Gobi Nuclear Waste Site--A large-scale nuclear waste disposal facility is planned to be constructed on the edge of the Gobi Desert, far from densely populated areas and will be in an area of the desert where the wind velocity reaches 17 meters/second so that the radioactive material can be dispersed easily and quickly. [40081020 Shanghai JIEFANG RIBAO in Chinese 14 Dec 88 p 1]

Nansha Observatory Station--China's Nansha Yongshujiao marine observatory has survived a typhoon, high temperatures and humidity. To date, it has functioned normally for 150 days and all equipment and instruments are operating normally. Recently, the State Oceanography Bureau, the State Meteorological Administration and navy specialists carried out tests of this monitoring station and confirmed that all performance indexes had achieved design specifications. The Yongshujiao marine observatory is China's first integrated hydrographic and meteorological monitoring facility in the Nansha marine area and all equipment and instruments on the station were developed independently by China. Since the completion and entry into operation of this station on 1 August 1988, it has promptly sent hydrographic and meteorological information about the Nansha marine area to concerned State organs on a daily basis. With respect to safeguarding China's development of marine resources, maritime communications, and transportation, and national defense, the station has proved invaluable. [Summary] [40081017d Beijing RENMIN RIBAO in Chinese 30 Dec 88 p 3]

Intelligent Global Data Models for Computer Integrated Manufacturing
Systems

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Research Center: "Establishment of Intelligent Global Data Models for
Computer Integrated Manufacturing Systems"; manuscript received
28 Jul 87]

[Text] Abstract

Data management is a key technology in computer integrated manufacturing
systems (CIMS). This article is a rather extensive discussion of
primary questions in data management for the establishment of global
data models. The article first analyzes various data (including
complex engineering data and abstract data) types and their
characteristics. It then uses a full system perspective to suggest
requirements for data models, and points out that traditional
hierarchic, network-type, and related models cannot serve as global data
models for CIMS. On this foundation it suggests the integration of
object-oriented methods with semantic association models to form object-
oriented semantic association models to serve as CIMS intelligent global
data models.

Key words: system architectured; data processing; artificial
intelligence/global data models; computer integrated manufacturing
systems

China Published Information Category Number: TP392

0. Outline

China has chosen CIBS as a high-technology topic to undertake in order
to catch up with advanced world S&T. Research on CIMS is very important
for top-quality, highly efficient, flexible, economic, and reliable
production, particularly in dangerous or adverse environments. It is

even more important for achieving full-plant automation. To make CIMS more economically competitive, we must provide decision-making, management, design, planning, manufacturing, inspection, and other links with the accurate and timely data they need. Thus, integrated management of full-system data is the foundation and nucleus of full-system software integration. For this reason, we must first analyze full-system data types and characteristics as a foundation for proposing methods for comprehensive description of all data types and interrelationships, meaning the establishment of suitable data models for global data.

I. CIMS Data Types and Characteristics

CAD, CAPP, CAM, CAT, CAE [computer-aided design, production planning, manufacturing, testing, and engineering] data used for "flexible drive" decision-making and management can be divided into three main groups according to data type regardless of the various different computer unit systems from which they came.

1.1 Transaction management type

Most data in CIMS product management and production regulations belongs to this type. It has a simple format, usually alphanumeric symbols or Boolean values. The essence of the data often can be described in a few records. Most of the 100-plus commercial database management systems (DBMS) now in use are oriented toward the transaction management type. Almost all the data models in these systems are of the traditional hierarchical, network state, relational, and other types.

1.2 Engineering data type

Much of the data used in CIMS belongs to the engineering data type. This type of data has the following characteristics:

1.2 1 Complex data type

CIMS engineering data comes in multidimensional vectors, matrices, aggregates, ordered sets, time series, geometric graphs, complex data formulas, processes, and other forms. Traditional data models cannot clearly and fully express these complex data structures, operations, and restraining conditions. To compensate for this inadequacy, users of applied engineering data are forced to add various supplements in applied programs. This affects the simplicity of using data and often poses a serious obstacle to the realization of real-time control, self-adaptive control, and other requirements. For this reason, many have studied ways to establish models for complex engineering data in the past few years. For example, when using spatial coordinates for three-dimensional vectors to control robot operations, can three-dimensional vectors serve as basic data items (or attributes) and be stored in data bases? Three-dimensional vectors should be the basic items for both search and detection to enable controllers to accurately and quickly differentiate robot states.

1.2.2 Dynamically varying data type

In CAPP, all subprocedures (processing sequences) during operation are extremely important. For example, a part is processed according to processing sequences at certain particular work stations, meaning that the various subprocedures at the work stations change in an ordered and continuous manner. Inspection of the part first of all requires dynamic data on changes in the location of the part over time. This dynamically varying data can be found in plant- and workshop-level documents and sub-databases.

1.2.3 Data "structure" type

CIMS events and objectives usually are described by many attributes. From the perspective of writing applied programs, "structures" often are used to define objectives or events, and they also conform to much specifically structured data.

1.2.4 Recursive definitions of data

In part design and inspection databases, recursive structures are very effective in describing part characteristics. For example, a diagram for drilling a group of holes into the surface of a part may be a complex graphic. It can be defined, however, using the basic diagram of the holes and the locational relationships between these basic graphics. The basic graphics also can be complex diagrams and can be defined by simple graphics and the locational relationships of simple graphics. This gives the graphic description of these holes in the part recursive characteristics.

1.2.5 Complex objects

An engineering object often is composed of many parts. The engine of an automobile, for example, is composed of cylinders, sparkplugs, and other components. The cylinders also can be defined by two groups of recorded actual values. The sparkplugs also are defined by eight groups of sparkplug recorded actual values. It is very hard to use attributes as atomic relationship data models to describe this type of complex objective clearly.

1.2.6 Cyclically varying data type

There is much cyclically varying data at work stations which process or inspect similar parts. Examples include data describing the motions of robot arms which move parts and data on knife cutting and extraction, all of which undergo cyclical variation from the start of part processing to completion. Obviously, simple data models cannot describe the characteristics of these cyclical variations.

1.2.7 Data segmenting and replication

Two types of segmentation methods can be used for CIMS data documents. The first method divides the columns (attributes) or lines (records) of the document according to semantics. This method often is used during database conceptual design. The second method divides the whole body into several documents and uses a distributional format during physical implementation to store these documents in several basic computer systems. The distributed stored document meets the requirement for locally available data and avoids tie-ups in long-distance storage and retrieval. Both methods can be segmented horizontally or vertically. The constraint and allocation of the integrity of the related segments should be determined clearly by the data model and by using a distributed DBMS to compel actual data identity.

Sometimes, some basic computer systems can be separated from CIMS for independent operation (for unit testing, maintenance, etc). At this time, the stored operations can destroy integrity constraints. As a result, there must be greater constraint of distributed data operations, and the data distribution, replication, and segmenting should be stored in a data dictionary.

1.2.8 Establishment of sub-databases

CIMS often requires the formation of sub-databases composed of loosely related data and a restricted operational content within them. For example, heat, tension, loading and other testing may be necessary before processing a certain part, and each type of test generates data on measurement results. This data in conjunction with original part design data can form a type of design program. This program should be used as a unified entity for addressing and operations, and it can be used as a sub-database.

1.2.9 Statistical classification data type

In classification of products, materials, and so on, statistics are an indispensable part of production management and quality control. This requires that data models have this function and that statistical classification be separated from other functional regions.

1.3 Abstract data type

Various types of expert systems are required in CIMS decision-making and management, processing plans, assembly techniques, quality control, full-system simulation, and other things. How can the special rules of expert systems and the data they use be managed? In conventional methods, it is possible only by separating expert systems and database systems into two independent systems, but this causes many problems with full-system integration. The cost also is high. Explorations now are underway using methods involving abstract rules, complex engineering data, and transaction management data for comprehensive management. Obviously, the only correct path for integration is to integrate

database techniques closely with artificial intelligence technologies to first of all establish intelligent data models which can describe the structure, operation, and restraints of these three types of data.

II. CIMS Requirements for Global Data Models

2.1 Global data models should be unified data models

Unification is essential for achieving integrated management of global data and for assuring the achievement of data inter-transmission and inter-communication within the full system network.

2.2 Global data models should have sufficiently strong functions

They should be able to describe the full semantics of transaction management data types, complex engineering data types, and abstract data types. When describing semantics, there must be clarity and absolutely no confusion.

2.3 Global data models should satisfy the speed requirements of real-time and self-adaptive control on data management

For this, models must be semantically rich to reduce or prevent the use of other compiling semantics to explain the programs during operation.

2.4 Global data models should be easy to use

Develop simple Chinese characters, graphs, and other user-friendly interfaces to enable users to learn how to use them quickly.

2.5 Global data models should be easily expandable

They should be able to add to their descriptions of the performance of new data types following system expansion and incorporation of new technical achievements. This is technically feasible and economically rational.

III. Using Object-Oriented Semantic Associative Data Models as Global Data Models

3.1 The meaning and characteristics of object-orientation

The object-oriented method is a new technique which has developed quickly in the realm of information processing technologies in recent years and has great vitality. The following advantages are apparent in the adoption of object-oriented method for data models:

3.1.1 The characteristics of data abstraction

Data abstraction is an important method for observing and structuring data. Abstraction refers to ignoring or eliminating the fine details of data to concentrate attention on the qualities common to and existing universally in the object aggregate.

Data abstraction qualities permit the system or the user to define the data type. This is an extremely important characteristic for establishing models for much extremely complex data in CAD/CAM databases because it can make full use of data and thereby enable users who are most familiar with its abstract characteristics to participate in establishing global data models and assure that important basic topics are carried out quickly and with high quality.

3.1.2 It allows separation of object type qualities (such as object type name, specific sampling, operations, parameters, etc.) from object implementation (such as internal memory architecture, processes and functions related to the object type, and other implementation methods). This means that users do not need a detailed understanding of the international architecture of a database, nor must they understand this type of complex DBMS software. This makes it possible to interface high-level non-process users with the DBMS, which is extremely ideal for applications.

3.1.3 Variable sampling and operational inheritance

Sub-type variable sampling and operations involve inherited super-type variable samples and operations. This characteristic greatly simplifies database definition and can strengthen system performance. Thus, it is an extremely important characteristic.

3.1.4 Identical data and metadata processing methods

The complete identity of the concepts of processing object types and processing objects is reflected in the identity of data and metadata processing methods in a DBMS. Moreover, in a complex software system (such as in a DBMS, this identity of processing can be expanded to any section of a program and program modules can be re-used. This characteristic is extremely useful.

3.2 Semantic associative models

A semantic model is a semantically rich data model. It contains many general-purpose modeled architectures which clearly describe the semantic qualities of the database. If the object-oriented method is combined with semantic data models, the object-oriented semantics should point out relationships between the object type and other object types, that is the architectural characteristics. Low-level data operations like searching, insertion, deletion, updating, and so on, as well as high-level user-defined operations like rotating, reflecting, getting, and rejecting parts are operational characteristics. Semantic

constraints and rules for integrity and completeness serve as threshold knowledge expressions for expert rules and general-purpose interface rules, so they are knowledge rules. These three semantic characteristics should be stored in a data object or object type format in the database.

Semantic models have these advantages over conventional basic data models:

3.2.1 Many benefits for database users, designers, and management personnel

The extremely complete, clear, unmixed, and direct description of the semantic qualities of a database during its establishment, utilization, and maintenance make establishing, using, and maintaining the database extremely convenient.

3.2.2 Establishment of a DBMS using semantic models can have stronger functions:

1. They clearly understand user inquiries and requests, and they use an extremely simple and clear format to express this type of inquiry and do not need to repeat already-defined semantic properties.

2. They compel applied knowledge rules and restraints.

3. They optimize inquiries to provide easy to use, functionally powerful, and highly efficient inquiry methods.

3.3 Characteristics of object-oriented semantic associative data models

We feel that CIMS global data models should use an object-oriented semantic associative data type. This type of high-level data model has these obvious characteristics:

1. It uses object and object type association for unified representation of all semantic properties. These semantic properties can be expressed in a new structure to make them convenient for CIMS users, designers, and maintenance personnel. It also means that one can consult the appropriate graphs, tables, languages, and so on as needed to express all semantic qualities.

2. The associative format expresses extremely common and general-purpose semantic and structural relationships. These associations are common in actual values among object levels or object types. All user-defined object types of system-defined object types can have a clear associative combination, while other types of clear associative combinations can be used between user-defined object types. The semantic properties of one object type often are described and explained in greater detail using associations with other objects or other object types.

3. Recursive definition and nested definition

One object type can be defined using another object set, and it can be defined by using itself directly or indirectly. The properties of this type of nested and recursive definition of object levels permits the definition of extremely complex architectures and complex semantic associations in CIMS, and it can achieve extremely clear and accurate definition of them.

4. Inheritance in outline hierarchical systems

There are five types of semantic associations in object-oriented semantic associative models. They are aggregate associations, interactive associations, combined associations, cross-product associations, and outline associations. Outline associations and outline hierarchical systems inherit object type attributes and operations as well as knowledge rule functions. Outline associations permit different data in the same object type to be allocated to different object type hierarchy systems, so models established for different perspectives of the same object are the same as general-purpose relationships among the various object levels.]]

5. All types of knowledge rules are synthesized in the object type definition

Rules associated with each type of object and each object type should be defined together with the object types, and they should be stored together. When these objects or object types are being processed, these rules also are prepared along with them for use. Thus, object-oriented semantic data models also can serve as a model to express knowledge for use in defining and synthesizing a knowledge repository. They also can serve as global data models for CIMS.

References

1. Sn. Stanley, Herman Lam, et al., An Object-Oriented Computing Environment for Productivity Improvement in Automated Design and Manufacturing, ACM, January 1987.

2. Sn. Stanley, Modelling Integrated Manufacturing Data with SAM*, IEEE, COMPUTER, January 1986.

3. Doinysios, C. Isichirizis, DATA MODELS, Prentice-Hall, Inc., 1982.

4. John Grant, LOGICAL INTRODUCTION TO DATA BASES, Harcourt, Brace, Jovanovich, 1987.

5. Henry F. Korth and Abraham Silberschatz, DATA SYSTEM CONCEPTS, McGraw-Hill, 1986.

Dalian Modular Machine-Tool Research Institute's Demonstration Flexible
Manufacturing System ZHS-FMS-02

Introduction, Overview

40080042 Dalian ZUHE JICHUANG YU ZIDONGHUA JIAGONG JISHU [MODULAR
MACHINE TOOL & AUTOMATIC MANUFACTURING TECHNIQUE] in Chinese No 8,
Aug 88 pp 2-5

[Article by Chen Dingqing [7115 1353 1987] of Dalian Modular Machine
Tool Institute; see also JPRS-CST-88-023, 5 Dec 88, pp 124, 126-28]

[Text] In order to gain experience in the manufacture, adjustment and
use of a flexible manufacturing system (FMS), a simple and economic FMS
scheme was selected based on our analysis of the development trend of
FMS abroad and on the technology available in China. It consists of two
flexible manufacturing cells, rail-guided carts, pallets, a pallet
station and a control station. It can schedule production plan and
automatically complete machining of box parts [i.e., casings] and
accessories with optimal utilization of the pallets. (See cover page.)
(Note: This product received a "Chunyan" gold medla in the 1988 Chinese
Modular Machine Tool Exhibit.)

1. FMS-02 and Its Principal Technical Specifications

1.1 Introduction

The layout and components of the flexible manufacturing system are shown
in Figure 1 [see following page].

As shown in the figure, the two flexible manufacturing cells are located
on one side of the guided rail. The control station and a loading area
are located at the right of the guided rail. Parts are loaded onto the
pallet at the loading station. Pallets are transported by cart to the
exchange unit at the cell and then delivered to the rotating work
station [i.e., the "turntable"]. After the pallet is identified, the
appropriate machining program is called to machine the parts. If the
machine tool is tied up and there is a pallet waiting at the exchange

Figure 1

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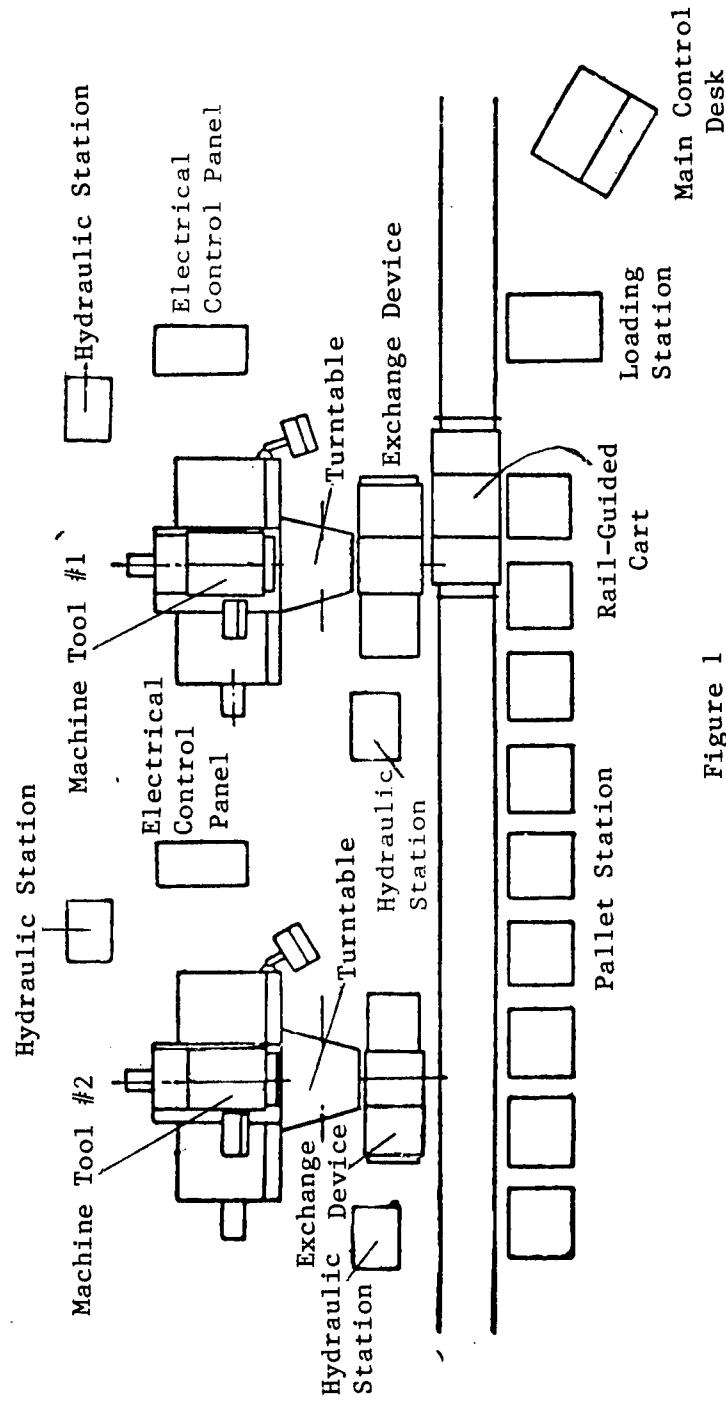
unit to be processed, the cart would deliver the pallet to the nearest available pallet station to be dispatched later. A machined pallet is taken out from the exchange to be delivered by cart to the loading station, or a nearby vacant pallet station. The system continues to operate in this manner until all parts are automatically machined. Based on the tool capacity, type of machining and program capacity of the machine tool, the two cells may complement each other, or replace each other in machining. In conclusion, this system can be used to investigate a series of problems associated with the flexible system.

Due to economic considerations, we first built one flexible machining cell. In the future, we will add another unit to make a true FMS.

1.2 Technical Specifications of Major Equipment of the FMS

pallet dimensions	500 x 630 mm
X – coordinate travel	800 mm
Y – coordinate travel	500 mm
Z – coordinate travel	550 mm
three-coordinate feed speed	1 – 4000 mm/min
three-coordinate fast moving speed	10 m/min
main axis rotating speed range	15 – 1500 r/min (arbitrary)
main axis drill size	40#
main electrical motor power	5.5 kW (continuous)/ 75 kW (30 min)
tool capacity	18 (any choice)
maximum tool length/diameter	320 mm/100 mm
maximum tool weight	8 kg
tool change time	23 s
three-coordinate location accuracy	± 0.015 mm (total)
three-coordinate location reproducibility	± 0.005 mm
turntable scale accuracy	± 3"
turntable scale reproducibility	± 1.5"

location reproducibility of same pallet	± 0.005 mm
location reproducibility of different pallet	± 0.025 mm
fast rail-guided-cart moving speed	32 m/min
rail-guided-cart positioning speed	3 m/min
rail-guided-cart first/second positioning accuracy	± 1.5 mm/± 0.02 mm
rail-guided-cart load capacity	800 kg

2. Three-Coordinate Flexible Manufacturing Cell

The primary research interest at Dalian Modular Machine-Tool Research Institute is in machining lines involving machining of a large quantity of parts. To this end, we are dedicated to the development of flexible manufacturing lines (FML) and full-feature, special-structure flexible [machining] cells (FMC). In response to design and production requirements, the principle of machine-tool modularization is introduced to the central machine tool. The central machine tool is also composed of general modular components. Different modular components are used to form different machining centers to meet various special machining needs. Thus, the design and manufacturing cycle of the machine tool is significantly reduced, the reliability of the machine tool is raised, and the cost is lowered.

2.1 Coordinate Moving Module

The central processing machine tool generally has three moving coordinates in X, Y and Z direction. These three moving coordinates are concentrated on one side of the vertical column, as shown in Figure 2. Similar to the power head of a modular machine tool, it is not only easy to set up linear FML but also easy to place it in a modular machine-tool line to expand its flexibility. Of course, it is a central machine tool when equipped with a turntable and tools. This module has two other special features. The three moving coordinates use linear rolling guide rails which are rigid and highly sensitive. All coordinates can be clamped down for high power cutting.
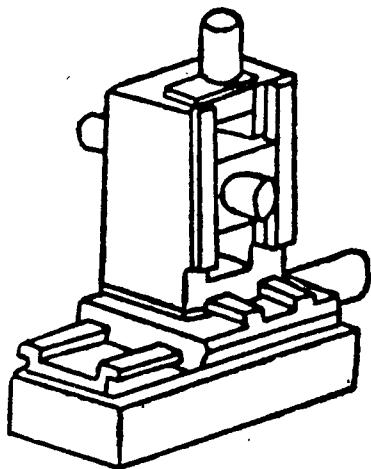
Figure 2

2.2 Tool Bin and Mechanical Arm Module

There are many ways to change tools and each one has its own special characteristics. In order to meet the requirements of various machine-tool accessories the tool bin and mechanical arm must be separated from the vertical column and main axial box. The tool bin size may vary. It may or may not be equipped with a mechanical arm. Figure 3a shows our present tool bin design. It is an oval chain-driven type bin without a mechanical arm standing on the left of the vertical column. The bin turns 90° to the right to deliver the tool in front of the main chuck when tool change takes place. The tool is placed or removed by horizontal movement. This kind of tool bin is suitable for a FML. In a FML each position involves a small number of procedures and requires a few tools only. Therefore, the tool bin capacity requirement is low. The present capacity is 18. This design only needs a few moves in a tool change. It is simple and reliable.

The plan also includes a type b tool bin (see Figure 3b). It has higher capacity and uses a mechanical arm. It will replace the type a tool bin in machining complicated parts.

(a)   (b)
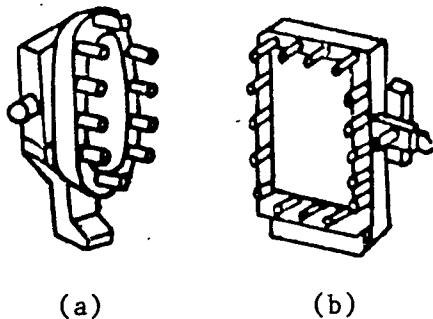
Figure 3

To meet the needs of machining a variety of parts in small quantity, we
are considering setting up a large tool bin on the left side of the
machine tool which holds more than 100 tools.

2.3 Turntable Module

A turntable [i.e., rotating workstation] is installed in front of the
three-coordinate moving module to allow the machine tool to machine a
part from several faces. We chose a hydraulic turntable which is
commonly used in modular machine tools, added some signals and made some
modifications before putting it in the system. This turntable is
divided into eight equal parts. It relies on a gear for positioning and
it is dependable. Of course, a digital-control turntable may be used.
However, it should be designed based on the modularization theory for
convenience in use.

2.4 Pallet Transport and Exchange Module

There are many ways to do automatic pallet control (APC). We chose a
dual-slot moving platform and chain-driven exchange device. One pallet
is being machined while the other is being loaded or unloaded to ensure
high-efficiency utilization of the machine tool. The chain-driven
exchange device employs a hydraulic motor and a gear-reduction mechanism
to move the chain forward or backward. A pallet can be moved around,
delivered to the turntable, or pulled away from the turntable by pegs on
the chain. This type of set-up is very practical for an FMC or FMS. It
is simple and reliable. Therefore, we designed it as a general module.

3. Pallet Rail-Guided Cart and Pallet Station

The material flow system for a FMS can be divided into two parts. One
is the delivery of parts from the outside and the other is the internal
transport of "parts + jigs + pallet." Parts are being delivered to the
system manually because of the varieties involved. It is a very complex
process to put a part on a jig which is difficult to automate without

getting into a complicated structure. When it is done manually, it only requires a loading station with a rolling machine. Each pallet station only requires a rolling machine and a steel-ball location mechanism.

Transport of materials inside the system is done with automated rail-guided carts. It is structurally simple and easy to operate and meets the requirements. Based on the specifications of the pallet, a series of dimensions has been designed for the automated rail-guided cart. The cart is designed to handle pallets under 630 x 630 mm. It is driven by a dc servo motor and has the capability to accelerate or decelerate automatically. The highest speed is 32 m/min and the lowest positioning speed is 3 m/min to ensure transport efficiency and location accuracy. The cart is equipped with a fluid tank which allows the four positioning tanks to be anchored in place. The cart is running on two rails mounted on a steel plate which has various anchor pins and barriers mounted on it to ensure accuracy and proper identification of the work location. The cart is also equipped with a pallet-exchange device. It consists of a hydraulic motor which drives a chain with two pegs. It moves the pallet right or left perpendicular to the rail to finish the transport of the pallet between the cart and the exchange device at the station. Bumpers are installed in the front and back of the cart. When the bumper is hit, the cart will be stopped immediately to ensure safety.

The rail-guided cart is controlled by the PC [programmable controller] developed at our institute. The PC receives commands from the system control computer to control the forward and backward movement of the cart and the motion of the exchange device.

The pallet used in the system meets international standard. Its specification is 500 x 630 mm and it is numbered according to binary code. The pallet station and exchange positions are equipped with code-identification switches to allow random access of the pallet.

4. Control System

The system has two levels of control. The machine tool is under CNC [computer numerical control] control and the cart is under PC control. This is the last level. The level is micro-computer controlled. A FANUC-3M system is used as the machine-tool controller. It stores the programs used to machine the parts to control the three-coordinate machining cell. The rail-guided cart is controlled by PC.

System control is accomplished by a modified TP805 with in-house-developed interface and software. The software ensures the optimal choice of the tools required for the job to maximize productivity. Economically, it is also the least costly system.

4.1 Production Control Principle

(1) Parts are machined according to priority:

When the production plan is drawn up, parts are assigned in sequence of priority such as A, B, C, D, E. Parts of higher priority will be machined first if conditions are equal.

(2) "First in, first out" principle:

Once a pallet enters the systems, it will be machined as soon as possible to make sure that all the machining is done as early as possible in order to return to the unloading position to be taken out of the system.

(3) "First delivery, first removal" principle at the pallet-exchange position:

To ensure maximum utilization of the machine tool, when the machine tool finishes a pallet it must be removed immediately. Another pallet must also be delivered right away. Therefore, a new pallet should be delivered to the exchange unit whenever a vacancy exists. If a finished pallet is sitting at the unit, it should be moved away first. This is the "first delivery, first removal" principle.

(4) Principle of nearby storage of pallet:

All pallets loaded with unfinished parts that cannot be sent to the turntable exchange unit or with finished parts that cannot be delivered to the loading station must be temporarily stored in pallet stations. The cart would choose the shortest route to store the pallet in a nearby empty pallet station.

Carts are dispatched based on the above principles, not only to meet production plan but also to maximize machine-tool utilization. The cart travels the shortest route to improve system efficiency.

4.2 Preparation of Production Schedule

In order to machine a number of parts, it is necessary to prepare a production schedule according to the table shown on the CRT [cathode ray tube] of the system control computer. A series of requirements and conditions, such as variety, quantity, program number, pallet number and priority, must be entered from the keyboard.

Priority	Quantity	Program Number	Pallet Number
A	10	2	1, 3
B	2	4	2
C	5	7	5
D	1	10	4
E			

The numbers in the table are entered from the keyboard. Finally, the total number of parts to be produced is entered at the upper right corner of the table.

Once the table is prepared, the system can be started.

After the system begins to operate, parts are machined according to the sequence of A, B, C, D, E. Once a part is finished, the total number in the table is reduced by one. Until all the parts are done, the total number of parts to be machined becomes zero.

It is necessary to make sure that pallet number and program sequence are in agreement to avoid conflict.

4.3 System Status Monitoring and Display

(1) Monitoring of Operation

The system can monitor the results of some control commands. If such a command is not implemented or is not logical, an error message will be displayed on the CRT. In addition, the system will be stopped.

(2) Display of Status

In order to have a handle on the operation, the system displays the dynamic status on the CRT in the form of a simluated diagram. For instance, the positions and movement of the carts, current condition of the machine tool, locations of all pallets and the implementation of the production schedule are displayed on the screen to allow the operator to understand the system.

The successful development of this FMS signifies that it is entering into a practical stage. As China makes more progress in computer technology, sensor technology and information technology and perfects the system control and management software, the FMS will also be significantly improved.

Rail-Guided-Cart Handling System

40080042 Dalian ZUHE JICHUANG YU ZIDONGHUA JIAGONG JISHU [MODULAR MACHINE TOOL & AUTOMATIC MANUFACTURING TECHNIQUE] in Chinese No 8, Aug 88 pp 6-11

[Article by Lu Guoman [7627 0948 3341], engineer at the Dalian Modular Machine Tool Institute]

[Text] At the 1988 Chinese National Machine Tool Exhibit [see JPRS-CST-88-023, 5 Dec 88, pp 126-27], Dalian Modular Machine Tool Institute displayed the ZHS-FMS-02 flexible manufacturing system (FMS) as a demonstration system. It was well received by the leadership and end users in the industry.

This paper describes the development of the linear rail-guided cart used in the system.

1. Factors to be considered in the development of the linear rail-guided cart

1.1 Material handling system is an important component of an FMS.

An FMS primarily consists of a machining cell, control system, inspection system, software and handling system.

The handling system is divided into tool handling and materials handling. A tool handling system is equipped only when the system is relatively large and the degree of automation is high. Materials handling, however, is required in every FMS.

The materials handling system includes materials (pallets, parts), transport means (rail-guided carts, other types of carts, rollers and conveyer belts), storage facilities (loading stations, pallet stations or buffer stations) and information exchange and operational control equipment. Its functions are:

(1) to implement the dispatch and transport of pallets and parts at loading stations, pallet stations, machining cells and ancillary equipment (such as cleaning equipment and inspection facilities) according to software control.

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(2) to serve as a buffer storage for pallets and parts during address change before and after machining. The system has enough pallet stations, comparable to the number of pallets, to buffer the difference between machining time and loading time and the time difference between two machining cells. It is also used to store materials when the machine tool is operating automatically without human supervision to maximize its utilization rate.

(3) to control the equipment in the materials system and to manage the operating condition.

The materials handling system is an important component in an FMS. To choose a good materials handling system not only can ensure the supply of materials to maintain normal production but also can lower the cost to enhance the economic benefit of the FMS.

1.2 Why did we first develop a materials handling system with linear rail-guided carts?

In the early development stage, materials handling in a flexible manufacturing system is accomplished with rollers and conveyer belts to form a linear or circular transport system. Its speed is low, usually under 10 m/min, and it is not very flexible. In a linear system the loading and unloading positions are located at both ends and it requires a lot of workers. By the late 1970's, most MFS adopted a materials handling system using linear rail-guided carts. The flexibility was improved significantly. The system is also more open. Loading and unloading positions can be concentrated to reduce the number of operators. The rail-guided cart has higher weight-carrying capacity and travels at 20-60 m/min, which is several times faster than that of rollers or conveyer belts. As FMS technology advances, many manufacturers chose to use guided cart in the systems built in the 1980's to create a network for even better flexibility. The weight-carrying capacity of a guided cart is usually 1-3 tons and its maximum speed can reach 60 m/min.

China has just started working on FMSs. The following analysis was performed to determine which materials handling system to develop in China.

(1) As discussed above, a linear rail-guided-cart materials handling system has distinct advantages over other system comprised of conveyer belts and rollers. To develop a linear rail-guided-cart materials handling system at the start also would benefit the rapid development of FMSs in China.

(2) Although a rail-guided cart is not as flexible as a guided cart, it is, however, cheaper to build and more technically feasible to develop. It is also practical, reliable and easy to control. Guided carts are costly and technically more difficult to build. There is some degree of

difficulty in developing and grasping the technology. The requirements on the operating environment and conditions are also very stringent. It is not easy to accomplish with the present machine shops in China.

(3) A linear rail-guided-cart system can completely satisfy the requirements of a low-cost FMS in the present development stage in China. Based on expert projection, China will have 100 FMS lines by the year 2000 and most of them are low-cost FMSs with 2-7 machining cells. Based on our computation and analysis, a low-cost FMS with four machining cells processing parts of medium complexity only needs one rail-guided cart travelling at 30 m/min to handle the transport of pallets. This design was proven feasible in simulation. If the travelling speed of the cart can be increased and the time required to position the rail-guided cart and to exchange parts on pallets can be shortened, a linear material handling system using the rail-guided cart as the primary component not only can meet the requirements of a low-cost system but also can be useful in larger units to be built in the future.

(4) The linear rail-guided-cart system is easily expandable. The FMS technology is costly. Users that are anxious to use FMSs but do not have enough capital can get together and complete one design. Each user can implement the plan individually to gradually perfect the design. At the beginning, we will build smaller FMSs consisting of 2 to 4 machining cells. Based on operating and economic conditions, it is possible to gradually create a larger FMS by increasing the number of machining cells, extending the length of the rail and adding pallets and other necessary ancillary equipment.

1.3 Modular design of the rail-guided cart increases degree of generalization and reduces number of specifications.

(1) Increasing degree of generalization

A flexible manufacturing system has a lot of flexibility. It can be organized for random production. The capacity of the tool bin cannot possible meet all the requirements in machining a variety of parts. To this end, it is accomplished by replacing the tool bin or adding tools to the tool bin. In some larger systems, the replacement of tool bin or transport of tools to the tool bin of a machining cell is carried out by a rail-guided cart (with mechanical arm). As the range of applications expands, it is required to generalize the design of the rail-guided cart. The rail-guided cart portion should be separated to facilitate the installation of the pallet exchange module and mechanical arm module. To this end, the upper surface of the rail-guided cart should be flat and smooth with suitable position and space for ease of installation of various functional modules.

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(2) Reducing number of specifications

The Machine-Tool Standardization Society in the International Standards Organization (ISO) has prepared ISO/TC39 to standardize FMS pallets. It will be beneficial for China to adopt this standard since it will make it simple to interchange machining cells imported from various locations even if they are imported from different countries.

The international standard covers a wide range of pallet sizes, consisting of 16 sizes ranging from (length x width) 320 x 320 to 1600 x 1600 mm. An analysis showed that 8 sizes ranging from 500 x 500 to 1000 x 1000 mm are most suited for automobile, tractor, diesel engine and refrigeration industries. Among them, 500 x 500 and 500 x 630 mm, 630 x 630 and 630 x 800 mm, 800 x 800 and 800 x 1000 mm, and 1000 x 1000 and 1000 x 1250 mm have completely interchangeable pallet delivery bases and dimensions. Based on our analysis on the modular design of the rail-guided cart, except for the pallet-exchange module, all modules only require two specifications. Let us call the 500 specification Type I and the 800 Type II. A rail-guided cart composed of these modules can be used to transport the eight types of pallets described above. The range of applications of the pallet-exchange module can also be expanded by adjusting the position of the transport guide plate.

(3) Table 1 [see following page] shows the modules forming the rail-guided cart.

1.4 Concept of the Rail-Guided Cart Series

The rail-guided-cart series concept developed at the Dalian Module Machine-Tool Research Institute is also adaptable to a hydraulic-driven device. The models and dimensions are shown in Table 2 [following Table 1].

For comparison, the models and dimensions of the rail-guided-cart series manufactured by the KTM Corporation in the United Kingdom are listed in Table 3 [following Table 2].

2. Material Storage and Transport System in the Demonstration Unit of the ZHS-FMS-02 Flexible Manufacturing System

2.1 Major Equipment and Technical and Economic Specifications of the System

(1) The major equipment includes a rail-guided cart, four pallet stations, a loading station and a ground controller for the materials system.

Table 1

Model Number	Suitable Pallet Dimensions	Major Modules in the Rail-Guided Cart				
XXXX50	500 x 500 500 x 630	Ground Equipment Module (Model I)	Operation Module (Model I)	Pallet-Exchange Module (Model I)	Hydraulic Transmission Module (Model I)	Cart Control Module (Model I)
XXXX63	630 x 630 630 x 800			Modifying Guided Plate Based on Model I		
XXXX80	800 x 800 800 x 1000	Ground Equipment Module (Model II)	Operation Module (Model II)	Pallet-Exchange Module (Model II)	Hydraulic Transmission Module (Model II)	Cart Control Module (Model II)
XXXX100	1000 x 1000 1000 x 1250			Modifying Guided Plate Based on Model II		
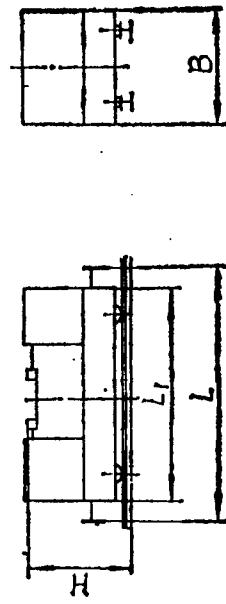
Table 2

Model Number	Suitable Pallet Size (l x w)	L (mm)	L₁ (mm)	B (mm)	H (mm)	V (m/min)	Maximum Weight (kg)	Drive Motor Power (kW)
×××50	500×500 500×630	2000	1700	1100	1060	40—4	1500	1.5
×××63	630×630 630×800							
×××80	800×800 800×1000	2500	2100	1600	1060	40—15—4	3000	2.5
×××100	1000×1000 1000×1250							

Table 3
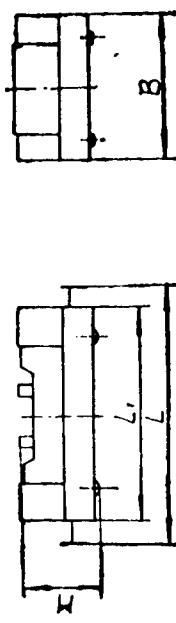
Model # of Machining Cell	Suitable Pallet Size (l x w)	L (mm)	L_1 (mm)	B (mm)	H (mm)	Maximum Weight (kg)	Maximum Operating Speed (m/min)	Operating Drive Motor Power (kW)
FM100	560×560	2100	1700	1100	1040	1000	30	1.5
FM200	760×760	2800	2200	1800	1050	2000	30	2.5
FM300	1000×1000	2800	2200	1800	1050	2000	30	2.5

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(2) Major technical and economic specifications:

pallet suitable for transport and storage (length x width) mm	500 x 500 (contract spec.) 500 x 630
maximum capacity of rail-guided cart, kg	800 (contract spec.) 1000 (design spec.)
maximum speed of rail-guided cart, m/min	30 (contract spec.) 40 (design spec.)
precision in re-positioning the rail-guided cart, mm	± 0.5 (contract spec.) ± 0.05 (measured)
operating drive-motor power for the rail-guided cart, kW	1.5
external dimensions of the rail-guided cart (length x width x height), mm	2000 x 1100 x 1185

(3) The operating characteristics of the rail-guided cart are shown in Figure 1.
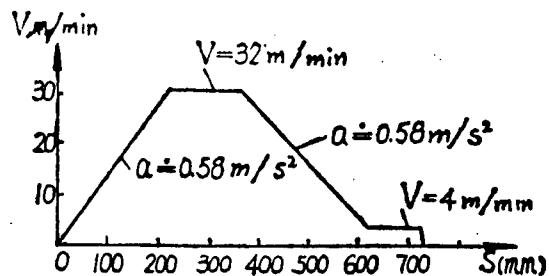
Figure 1. Measured Operating Characteristics of the Rail-Guided Cart

2.2 Major Modules and Structural Characteristics of the Rail-Guided Cart

The rail-guided cart consists of the ground rail equipment module, operation module, pallet-parts-exchange module, hydraulic transmission equipment module and control device and cable suspension equipment module.

(1) Ground rail equipment module:

Two light rails are installed on a steel plate with bolts. Screws are used to straighten these rails. A limiting switch and a buffer are

installed on either end of the light rail to prevent the rail-guided cart from going over the ends by accident.

(2) Operation module (see Figure 3):

The operation module is driven by a dc servo motor. Power is transmitted to the main drive shaft to turn the wheel through the decelerator. The speed of the servo motor is easy to adjust, and the motor is stable and reliable in operation. All wheels are equipped with brakes for emergency braking and positioning braking.

Two safety bumpers are installed; one in the front and one in the rear of the operation module. They are connected by two long rods and are supported by four springs of equal tension so that the safety plate bounces upon impact. When an obstacle comes in contact with the front bumper to compress the spring, the relative position between the bumper and the cart changes, triggering the limiting switch which activates the brakes to stop the cart for safety.

The body of the rail-guided cart is designed to be flat and smooth. The pallet and parts-exchange module is built in with space reserved to facilitate the installation of interchangeable functional modules.

(3) Positioning of the rail-guided cart:

The positioning of the rail-guided cart is done in two steps. It is positioned again after the first time. The first time, the counter switch sends a signal to stop the motor and to apply the brakes when the cart arrives at the target location. The accuracy of the first positioning attempt is checked by the check switch (positioning error is ± 5 mm) to determine whether a second attempt is required.

The working principles to verify the accuracy of the first positioning attempt is shown in Figure 2.
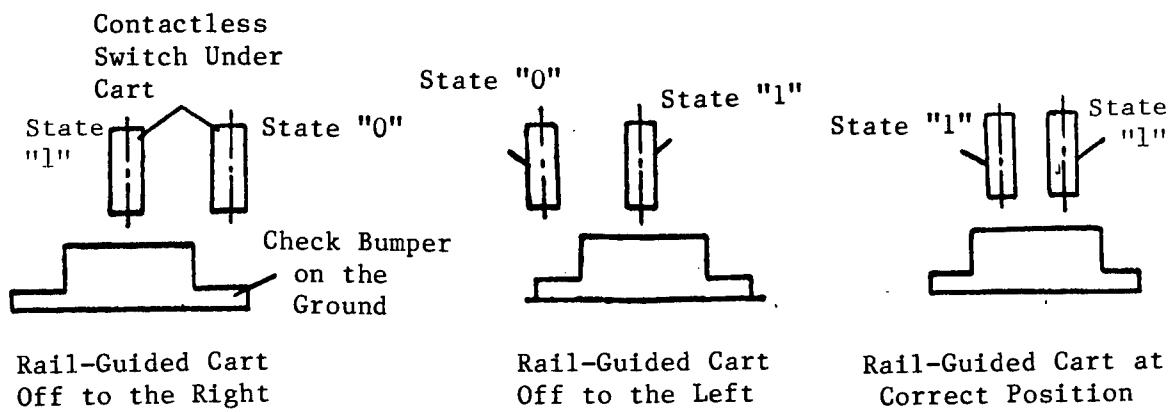
Figure 2

After the first attempt is confirmed, the second effort lines up the four pistons (with holes on the bottom) on the cart directly over the four positioning cones at the target location (see Figure 3).
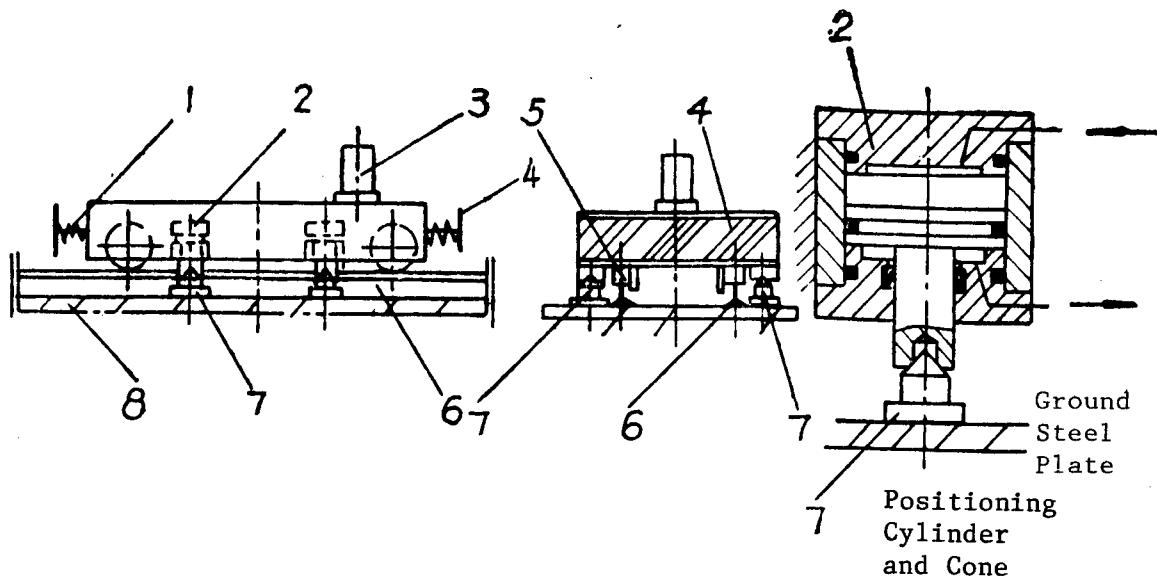
Figure 3. Operation Module and Positioning Mechanism:

1 - pressure spring
2 - positioning fluid cylinder
3 - dc servo motor
4 - safety plate
5 - wheel
6 - rail
7 - cone
8 - ground steel plate

The second effort serves two functions. One is to achieve a very high degree of accuracy in repeatability and the other is compensate for the error caused by the inconsistency in height among all machining cells.

(4) Pallet and parts-exchange module (see Figure 4):

The hydraulic motor 7 drives the double-row rolling chain around a horizontal plane. A long pin 1 and short pin 6 are installed symmetrically on the circumference of the chain. The long pin is used to pull the parts on the pallet and the short pin is used to push parts on the pallet, thus producing an exchange of parts. The speed of exchange is 7-9 m/min which is controlled by a speed adjustment valve.
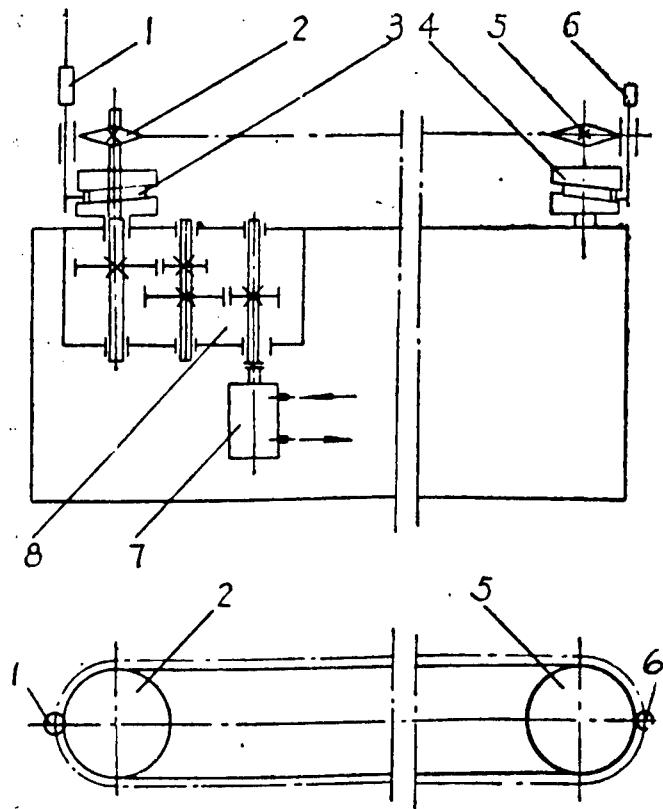
Figure 4. Schematic Diagram of the Pallet-Exchange Module

1 - long pin
2 - chain gear
3 - cam
4 - cam
5 - chain gear
6 - short pin
7 - hydraulic motor
8 - decelerator

The principles of exchange between the cart and pallet station and between the machining cell and parts are shown in Figure 5.

Figure 5. Pallet-Exchange Principle
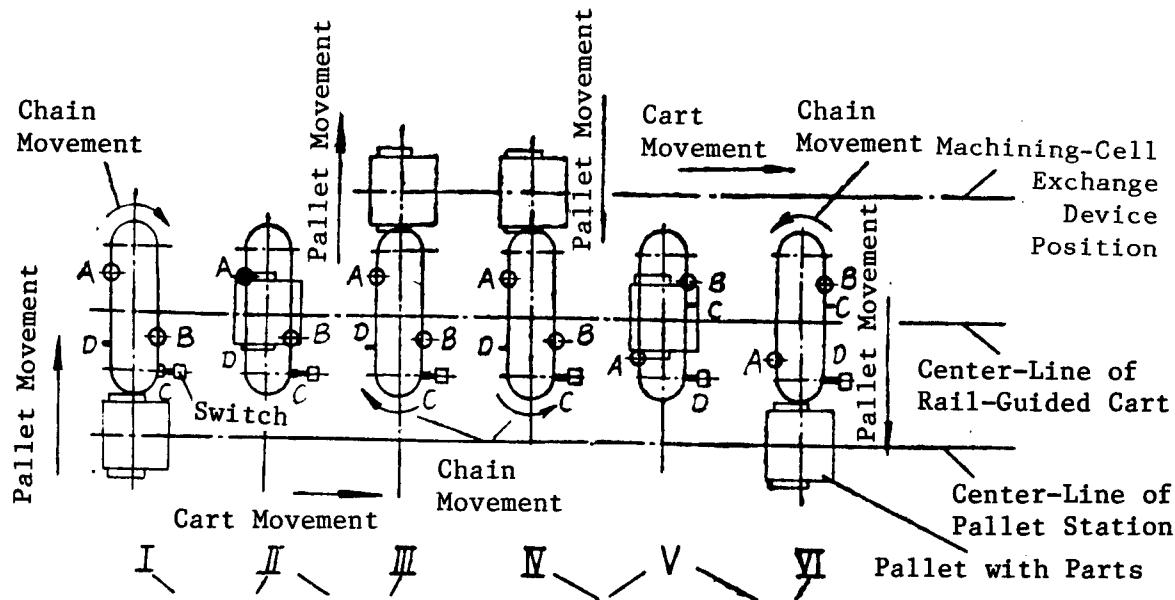
- When A completes a clockwise turn, the parts on the pallet are exchanged to the cart.

- When A makes another clockwise turn, the pallet on the cart is moved to the cell.

- When A moves counterclockwise for one turn plus the length of the pallet, the pallet is transferred from the machining cell to the cart.

- When A moves counterclockwise for another turn, the pallet on the cart is transferred to the pallet station.

A - long pin, B - short pin, C, D - switch protection

This exchange module is applicable to a machining cell with two fixed exchange devices. It has two special features. One is that a long pin pulls the pallet and a short pin pushes the pallet to shorten the exchange time for improved efficiency. The other is that cams are installed on both chain gears to make the long and short pin travel at different height in the working path as compared to that in the return path to avoid the need of a slot on the bottom of the pallet. Thus, the designed raigidity of the pallet can be insured.

2.3 Performance Testing of the Rail-Guided Cart

Table 4 [see following page] shows results of a test performed on the rail-guided cart.

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Table 4

No.	Test Item	Test Diagram and Instrumentation	Measured Values
1	Accuracy of First Positioning Effort		Empty: ±1.5mm Full: ±2.0mm
2	Accuracy of Second Positioning Effort	Position I — Position II; Electrical Comparator; Traveling Region of Cart; Rail-Guided Cart; Gauge; Rail; Digital Display	Empty: ±0.05mm Full: ±0.05mm
3	Determination of Acceleration During Braking		Empty: -0.58m/s^2 Full: -0.58m/s^2
4	Determination of Acceleration During Start-up	Position VI — Position VII; Accelerometer; Traveling Region of Cart; Rail-Guided Cart; Bridge; Strain Gauge; Oscilloscope; SC16; S Power Supply	Empty: 0.53m/s^2 Full: 0.53m/s^2
5	Gliding Distance from High Speed (32m/min) to Low Speed (4m/min)		Empty: 137.5mm Full: 149.6mm
6	Gliding Distance from Low Speed (4m/min) to Stop	Reading Head; Rail-Guided Cart; Optimal Grating; VII VI V; Operating Range; Stop Signal; Deceleration Signal; FF3, SC16; JWY-30B	Empty: 5mm Full: 5mm
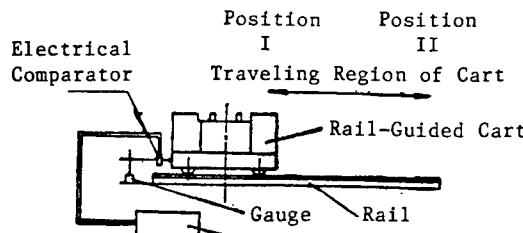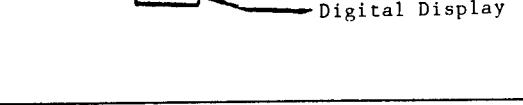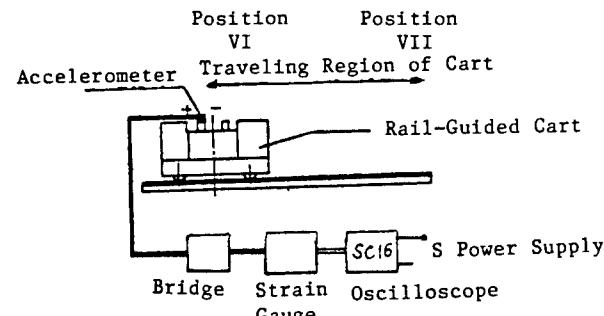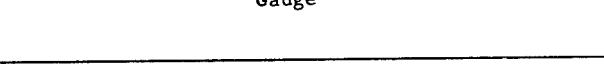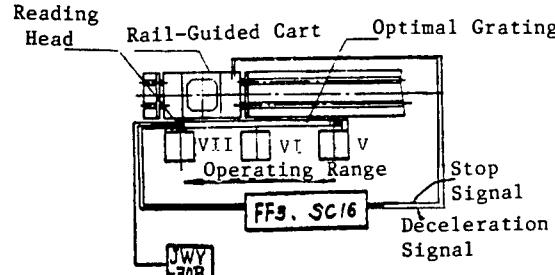
110
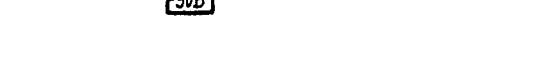
Briefs

New CNC Machining System--The National Defense University of Science & Technology has developed a microcomputer-controlled machine-tool system based on group-control machining principles. This machining system, which recently passed technical appraisal, unites 11 computer numerically controlled (CNC) machine tools under one host computer, for computer-assisted lathe work and other processes. [Summary] [40080135a Tianjin ZHONGGUO JISHU SHICHANG BAO [CHINA TECHNOLOGY MARKET NEWS] in Chinese 4 Feb 89 p 2]

New Flexible Machining Line--Applying microelectronics technology and group technology to transform its electric machinery end-housing [duan gai 4551 5556] production line, the Nanjing Electric Machinery Plant has united 11 microcomputer program-controlled lathes, numerically controlled lathes, and program-controlled modular drilling machines into a flexible machining production line for end housings. Yearly output has risen from 34,200 to 84,000, finished-product [acceptance] rate has risen from 95 percent to 99 percent; annual additional economic benefits of over 400,000 yuan have been created. The MNDC-36A microcomputer numerically controlled end-housing lathe, an integral part of the system, uses modular cutting tools for three-axis machining; one end housing can be processed in only 3 minutes. [Summary] [40080135b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 6, 8 Feb 89 p 22]

Fiber-Optic Sensor Development Described

40080096b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 46, 30 Nov 88 pp 61, 63

[Article by Zheng Runkui [6774 3387 7608] of the Seismological Research Institute [in the State Seismological Bureau]: "The Current State of Fiber-Optic Sensors and Their Development"]

[Excerpts] [passage omitted]

III. The situation regarding fiber-optic sensors both within China and abroad

A. The domestic situation regarding fiber-optic sensors

1. The development of fiber-optic materials

Since the founding of the PRC, dozens of units have been engaged in fiber-optic research and production, among them Qinghua University, Institute 34 of the Ministry of Electronics Industry, the Shanghai Silicate Institute, the Wuhan Institute of Posts and Telecommunications Science, and the Shanghai Xin Hu Glass Plant. The products of these units are primarily used in fiber-optic communications. In the past few years, single-mode optical fiber for use in fiber-optic sensors has been produced, but development has been uneven, and there must be further improvement in quality, to name one area. In recent years, many units have even imported optical-fiber-drawing production lines from abroad.

2. The development of fiber-optic sensors

Units currently engaged in the development of fiber-optic sensors are for the most part institutions of higher education and institutes. These include Qinghua University, Wuhan University, Beijing Science and Engineering University, Shanghai University of Science and Technology, China University of Science and Technology, Shandong University, Central China Science and Engineering University, Wuhan Institute of Building Materials, six institutes of the Chinese Academy of Sciences (the Institute of Mechanics, the Institute of Physics, the Changchun Institute of Optical and Precision Machinery, the

Shanghai Institute of Optics and Fine Mechanics, the Xi'an Institute of
Optics and Precision Mechanics, and the Anhui Institute of Optics and
Precision Mechanics), Wuhan Institute of Posts and Telecommunications
Science, the Seismological Research Institute of the State Seismological
Bureau, the Tongji College of Medical Science, the Shanghai College of
Medical Science, Xidian University [Xi'an University of Electronic Science
and Technology, formerly Northwest Institute of Telecommunications
Engineering], and others. Most of these are at an exploratory research or
experimental stage, but in recent years a number of experimental and
operational fiber-optic lines have been laid in the Shanghai, Beijing, Wuhan,
Nanjing, and Tianjin areas.

3. The current domestic level of fiber-optic sensors

Domestic fiber-optic temperature sensors are developing rapidly, and there
are trial products on the market. The "fiber-optic pressure sensor"
developed by the Wuhan Institute of Building Materials can be used to
measure liquids under hazardous conditions, and its performance with gases
is better than that of other sensors. It is in the forefront domestically,
and is currently in small batch production.

At present, all institutions of higher learning and institutes are actively
doing research on fiber-optic sensors, and they are preparing to overtake
the international standard during the period of the "Seventh 5-Year Plan."
Optical fiber factories are also currently making strong efforts to achieve
world standards for fiber-optic materials.

[passage omitted]

V. Directions for the Development of Fiber-Optic Sensors

In view of the situation regarding China's fiber-optic sensor development,
as well as the conditions currently prevailing and demands from the "Seventh
5-Year Plan," attention should be paid to the following areas regarding
these devices.

Research in fiber-optic sensors, and primarily: fiber-optic Doppler
tachometers, all-fiber-optic elliptical polarization sensors, fiber-optic
range finders, fiber-optic magnetometers, fiber-optic level monitors and
controllers, fiber-optic displacement sensors, fiber-optic pressure sensors,
fiber-optic sensor systems, single-mode fiber-optic double-arm interferometers,
thin-film fiber-optic sensors, high-temperature fiber-optic sensors, fiber-
optic temperature sensors, fiber-optic flow sensors, moving-body fiber-optic
temperature sensors, fiber-optic transmission alarms, fiber-optic laser
facsimile and copying machines, multifunctional fiber-optic sensors, fiber-
optic rotation sensors, fiber-optic welding monitors, gas-concentration
telemetry fiber-optic sensing systems, and fiber-optic acoustic sensors.

As we develop fiber-optic sensors, we should also pay attention to research
into the standardization, serialization, and regularization of these sensors.

Progress Report on China's Optoelectronics Research; Called 'World Class' by an American

40080094b Beijing GUANGMING RIBAO in Chinese 19 Dec 88 p 2

[Article by Zhu Wenqin [2612 2429 3830]: "The Developers of China's Optoelectronics Technology"]

[Text] Zhou Bingkun [0719 3521 3824], professor in the Department of Radio Electronics at Qinghua University and deputy institute director, is the leader of a group of experts affiliated with optoelectronics technology projects for China's high-technology development planning. He recently told this reporter that the research work of which he is in charge has been under development less than 1 year, but has already resulted in 19 achievements, among which four are at a level to be applied. Some developed nations are seeking to produce these cooperatively, and have already signed letters of agreement.

When the world's first laser was coming into existence in July 1960, Zhou Bingkun was at the Leningrad Academy of Electrical Engineering studying microwave quantum electronics, and he immediately shifted his studies to lasers. It was fortunate that he participated in the development effort for the first Soviet ruby laser, so he is one of the "founding members" of laser research. Two years later, Zhou returned to Qinghua University to found a small group for laser research.

In 1978, news of international developments in new technologies made the scholastically perceptive Zhou Bingkun aware that the information age was nearly upon us, and that optoelectronics was a technological industry with a future for application in the laser field. Without regard for the hardship, Zhou undertook deeply investigative research, which resulted in the determination that the laser teaching and research group he led would shift to research in developing optoelectronics. The laser specialty at Qinghua University was also changed into one in optoelectronics technology. In this way, Zhou abandoned the more than 10 years of painstaking work in solid-state and gas laser research to lead his teaching and research group in scaling new heights in a thorny new technology. They wrote general-purpose teaching materials such as "Laser Principles," "Physical Optics," and "Laser Spectroscopy," as well as the first comprehensive treatise on optoelectronics in China--"A Primer of Optoelectronics," which took 8 years to write and which was published in 1988 as a series of teaching materials.

Zhou went to the United States for study in the capacity of a visiting scholar, and during the 2 years he spent there, his solid-state laser (an optoelectronics-technology product) research achievements won three first prizes; he was said by foreign scholars to have "opened up new fields in solid-state laser research." Zhou predicted that "the 1990's would be the age of optoelectronics." After returning to China, he did a great deal of work in establishing China's own optoelectronics technology industry. He went all over popularizing the field and presenting scholastic papers; he visited with older experts and senior scholars; and he passed on recommendations to the relevant departments among the higher authorities. His scholastic understanding finally received the respect of others, and people accepted and understood what he had to say. In 1985, with state approval, the "State Laboratory of Integrated Optoelectronics" was founded jointly by Qinghua University, Jilin University, and the Semiconductor Institute of the Academy of Sciences, and in 1986 optoelectronics technology was included within state developmental planning for high technology. Zhou Bingkun was appointed to be the group leader for this team of experts. The burden is heavy, and there is a long way to go yet, but Zhou Bingkun is even busier. In addition to directing doctoral candidates, teaching classes for graduate students, and acting as deputy director, he will also be responsible for work at the Institute for Radio Electronics; he is concurrently also in charge of high-technology research projects for the state. Under his leadership, projects have been effective and progress has been smooth, and consequently they have gained outstanding results.

Since 1978, Zhou Bingkun has led his teaching and research group in optoelectronics research, making a great contribution to China's optoelectronics technology and industry. One PhD at Bell Laboratories in the United States praised him by saying that optoelectronics technology research efforts at Qinghua University are world-class. Over the past 10 years, they have successfully developed a narrow-band (100 Hz) external-cavity semiconductor laser that meets international standards, they have written 30 papers on related topics, and they have broadcast this achievement to all areas of the world. The fineness of the fiber-optic ring cavities they have developed continues to improve; this fineness ranges from 50 to 1260, which has startled American scholars, who say that this has been difficult even for foreign labs to achieve. In april this year [1988], they successfully developed the first domestic 40-micron-diameter monocrystalline optical fiber...

Since 1982, Zhou Bingkun has published 36 papers concerned with aspects of optoelectronics, and he has been directly involved with or has participated in the direction of 21 projects. Among these, six have been especially noteworthy, and some have gained international respect. Some have been awarded national patents; among these are a single-mode semiconductor laser which meets advanced international standards.

Mode-Locked Ar$^+$ Laser With a Nonresonant Ring

[Article by Xing Qirong [6717 1477 2837], Zhang Chen [1728 1820], and Wang Qingyue [3769 3237 2588] of Department of Precision Instrument Engineering, Tianjin University]

[Abstract] With respect to collision pulse mode-locking (CPM) with an Ar$^+$ laser, for the first time Kuhlke, et al., realized the operation in a straight-line cavity. Later, Wang Qingyue, et al., realized the same operation in a ring-shaped cavity. The paper reports the first experimental study on the realization of pulse collision mode-locking using an Ar$^+$ laser with a nonresonant ring.

Stability of the optical cavity was analyzed and the preliminary investigation results are given. A six-lens nonresonant ring arrangement (as shown in the following diagram) was used by the authors in the experiment for convenience in adjustment and output.
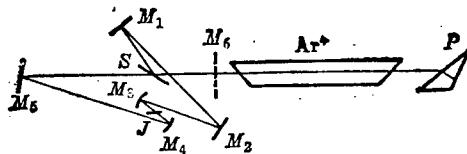
S is beam splitter.

Two other figures show a three-lens folded cavity and a picture of pulse train from a locked mode outputted from the laser. A table lists data showing the relation between the saturable absorber concentration and the locked mode operating range. The paper was received for publication on 14 May 1987.

REFERENCES

[1] A. E. Siegman, OPT. LETT., 6 (7), 334 (1981).

[2] H. Vanherzeele, J. L. Van Eck, and A. E. Siegman, APPL. OPT., 20, 3484 (1981).

[3] Han Rucong [7281 3067 5115], et al., YINGYONG JIGUANG LIANKAN [JOINT ISSUE OF APPLIED LASERS], 4 (6), 5 (1984).

[4] H. Vanherzeele, J. C. Diels, and R. Torti, OPT. LETT., 9 (12), 549 (1984).

[5] D. Kuhlke and W. Rudolph, OPT. COMMUN., 47, 7 (1983).

[6] Wang Chingyue, Xing Qirong, and Zhao Xinmiao, OPT. COMMUN., 55, 135 (1985).

[7] Wang Qingyue, YINGYONG JIGUANG [APPLIED LASERS], 4 (5), 225 (1984).

[8] Gong Zhenglie [7895 2973 3525], et al., TIANJIN DAXUE XUEBAO [JOURNAL OF TIANJIN UNIVERSITY], 1, 119 (1983).

[9] A. E. Siegman, IEEE J. QUANT. ELECTR., QE-9, 247 (1973).

Threshold Current for High Temperature Continuous Wave (CW)
Semiconductor Lasers

[Article by Wang Dehuang [3769 1795 3552] of Department of Physics,
Beijing University]

[Abstract] The relation between the threshold current (I_{th}) and
temperature (T) for high-temperature CW semiconductor lasers (LDs) are
analyzed by using the carrier rate equation. The contributions to T as
a function of the intracavity losses, bimolecular recombination and the
Auger process, as well as the effect of carrier leakage on I_{th} are
given, respectively, in calculations.

Four figures show effects on I_{th} and T stemming from four physical
processes: intracavity losses (A), interband bimolecular recombination
(B), Auger recombination (C), and carrier leakage effect (D); as well as
the relations between the calculated I_{th} value and T for AlGaAs DHLD and
InGaAsP DHLD. A table lists data showing contributions to the I_{th} value
of the laser device stemming from the four above-mentioned physical
processes at T=300, 400, and 500K.

The paper was received for publication on 11 May 1987.

REFERENCES

[1] A. Hayg, IEEE J. QUANT. ELECTR., QE-21(6), 716 (1985).

[2] A. P. Mozer, S. Hausser and M. H. Pilkuhn, IEEE J. QUANT. ELECTR.,
QE-21(6), 719 (1985).

[3] L. M. Dolginov, et al., IEEE J. QUANT. ELECTR., QE-21(6), 646
(1985).

[4] H. C. Casey, Jr. and M. B. Panish, Heterostructure Lasers (New York), Part A, 203 (1978).

[5] H. C. Casey, Jr. and M. B. Panish, Heterostructure Lasers (New York), Part B, 179 (1978).

New Possible Types of Two-Photon Three-Energy-Level Echoes

[Article by Li Shiqun [2621 1597 5028] of Department of Modern Applied Physics, Beijing University; and Chen Tianjie [7115 1131 2638] of Department of Physics, Beijing University]

[Abstract] The possibility of observing different types of two-photon three-energy-level echoes (TTE) is analyzed for various energy level configurations, populations and pulse train. The analysis shows that seven more types of TTE may exist and there are only two kinds of echo time. Since all possible configurations are analyzed, the TTE theory is perfected. Two figures show possible forms and a graphical method for depicting two-photon three-energy-level photon echoes.

The paper was received for publication on 27 June 1987.

REFERENCES

[1] Chen Tianjie and S. R. Hartmann, WULI XUEBAO [JOURNAL OF PHYSICS], 34 (8), 1034 (1985).

[2] T. J. Chen, et al., JOSAB, 3 (4), 493 (1986).

[3] T. W. Mossberg, et al., PHYS. REV., A20 (5), 1976 (1979).

[4] A. Flusberg, et al., PHYS. REV. LETT., 41, 305 (1978).

[5] T. W. Mossberg and S. R. Hartmann, PHYS. REV., A23 (3), 1271 (1981).

[6] Ye Peixian and Y. R. Shen, PHYS. REV., A25 (4), 2183 (1982).

[7] A. Flusberg, et al., PHYS. REV., A19, 1607 (1979).

Study on Liquid Crystal 4-N-Hexylbenzonic Acid-4'-Cryanophenyl Ester by Raman Spectra

[Article by Zhou Yixin [0719 5030 2450] and Huang Tao [7806 3447] of Department of Physics, Nanjing Normal University]

[Abstract] Raman spectra of 4-n-hexylbenzoic acid-4'-cryanophenyl ester (HBACPE)$_1$ were recorded and analyzed in the zones of 100 cm^{-1} to 1700 cm^{-1}. Compared with the liquid crystals of an aromatic ester, the molecular structure of the HBACPE spectral change in different phases, and the conformations of benzene rings and alkyl chain were discussed.

Two figures show Raman spectra of HBACPE liquid crystal, and molecular structures of liquid crystals CPPOB and HBACPE. One table lists Raman frequencies of beta$_{C-H}$ of liquid crystal HBACPE benzene ring.

REFERENCES

[1] B. J. Bulkin, in "Advances in Infrared and Raman Spectroscope," Vol 8, ed.: R. J. H. Clark and R. H. Hester (Heyden, London), 184 (1981).

[2] Pan Jialai [3382 1367 0171], Jiguang Laman Guangpu Zai Youji Huaxue Shangdi Yingyong [Applications of Laser Raman Spectra in Organic Chemistry], Chemical Industry Publishing House, 1986.

[3] T. V. K. Sarma, APPL. SPECTROSCOPY, 40, 933 (1986).

[4] R. O. Kagel, in "Handbook of Spectroscopy," Vol 2, ed.: J. W. Robinson, CRC Press, 107 (1974).

[5] Zhongxi Xiang'er [0022 6007 7449 1422, Chinese transliteration of Japanese name] and P. H. Solomon (both in United States), translated by Wang Xuming [3769 4872 2494], Hongwai Guangpu Fenxi 100 Li [100 Examples of Infrared Spectral Analysis], Science Publishing House, 1984.

[6] Daonei Wuyan [1497 0355 2976 1750, Chinese transliteration of Japanese name], Hongwaixian Guangpu Jiexifa [Methods in Infrared Spectral Analysis], Science Publishing House, 66 (1960).

[7] U. Baumeister and H. Hartung, Mol. Cryst. Liq. Cryst., 69, 119 (1981).

[8] Masagi Mizuno and Takako Shinoda, Mol. Cryst. Liq. Cryst., 69, 103 (1981).

Optical Processing of Images Speckle-Encoded by Means of Multiexposure Holographic Lens

[Article by Wang Zhaoqi [3769 5128 0967], Wu Faxiang [0702 3127 4382], Zha Yu [2686 1342], and Huang Qiuyuan [7806 4428 0337] of Institute of Modern Optics, Nankai University]

[Abstract] A new kind of holographic optical lens, multi-exposure holographic lens (MEHL), is fabricated. White-light optical processing of images speckle-encoded is realized with this holographic lens. MEHL can also be used for one-step slitless rainbow holography. The MEHL fabrication system is shown in the following diagram:
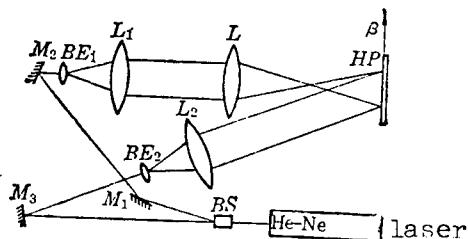
HP--holographic dry plate; BE--beam expander lens.

Five other figures show an optical system with MEHL to support speckle encoding, a white-light optical information processing system, a set of transparent film images used for speckle encoding, an output image after covering over the zero-frequency component, and an output after a band filter was used to cover over the horizontal and vertical diffraction haloes. The paper was received for publication on 6 July 1987.

REFERENCES

[1] Mu Guoguang [3018 0948 0342], et al., WULI XUEBAO [JOURNAL OF PHYSICS], 31 (11), 1547 (1982).

[2] Huang Degen [7806 1795 2704], et al., GUANGXUE XUEBAO [JOURNAL OF OPTICS], 4 (2), 139 (1984).

[3] Mu Guoguang, et al., GUANGXUE XUEBAO, 5 (2), 113 (1985).

[4] Wang Zhaoqi, et al., YINGYONG JIGUANG [APPLIED LASERS], 6 (3), 105 (1986).

[5] A. Beauregard, et al., APPL. OPT., 23 (18), 3095 (1984).

Experimental System of Optical Fiber Sensor for Current Measurement and Its Performance

[Article by Liao Yanbiao [1675 1693 1753], Yang Xueyu [2799 7185 6735], Wu Gengsheng [0702 1649 3932], Pan Anpei [3382 1344 1014], and Chen Guolin [7115 0948 7207] of Department of Radio Electronics, Qinghua University]

[Abstract] An optical fiber sensor for current measurement was constructed by using magneto-optical effect. The paper discusses the main problems, such as fiber selection and treatment, structure of sensing head and the method of forming the fiber coil, design of the detecting and processing system, and the adjustment of the optical system. The measurement results from using the experimental system are given as well. The following schematic diagram shows an optical fiber sensor system for current measurement:
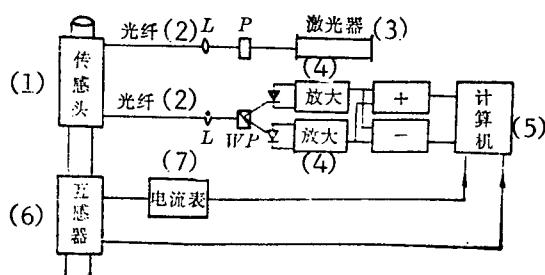
Key:
1. Sensing head
2. Optical fiber
3. Laser device
4. Amplification
5. Computer
6. Mutual inductor
7. Ammeter

Another figure shows the structure of optical fiber sensing head and the optical fiber winding method. A table lists data of current measurement results.

The paper was received for publication on 24 March 1987.

REFERENCES

[1] Smith, A. M., APPL. OPT., 17, 52 (1978)

[2] Yang Xueyu, et al., ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS], 14 (5), 308 to 312 (1987).

Phase Distortion in Degenerate Four-Wave Mixing by Means of Microperturbation Approximation Theory

[Article by Zhao Mingjun [6392 2494 0689] and Li Yulin [2621 5148 2651] of Xi'an Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] A perturbation approximation theory is used for analysis of phase distortion in degenerate four-wave mixing. It is seen from the calculation results that an important means of increasing the readout wave signal-to-noise ratio (s/n) is to reduce the resultant distortion ϕ of other waves.

A figure shows that each wave is a plane wave with a microanomaly; in other words, a plane wave front is acted on by a certain amount of microperturbation.

REFERENCES

[1] Y. H. Ja, OPT. COMMUN., 42, 6 (1982).

[2] Y. H. Ja, OPT. COMMUN., 44, 1 (1982).

[3] N. A. Vainos and R. W. Eason, OPT. COMMUN., 59, 3 (1986).

[4] V. Markov, S. Odulov, and M. Soskn, OPT. AND LASER TECH., April, 95 (1979).

[5] Y. R. Shen, The Principle of Nonlineor Optics, (Sohn Wiley and Sons, Inc. New York 1984).

[6] N. Chen, OPT. COMMUN., 59, 1 (1986).

Briefs

Advanced Radar Technique Invented--The "tangent-bend reflector single-antenna phase altimetry" [shuang wanqu fanshemian dan tianxian bixiang cegao] method invented by Nanjing Changjiang Machine-Building Plant engineer Chen Qian [7115 0051], after 11 years of experimentation and numerous trials, passed the expert commission appraisal held in Nanjing on 19 January by Tong Zhipeng [4547 1807 7720], Director of the Ministry of Machine-Building & Electronics Industry's Institute of Electronic Science. The feasability of using this dual-beam phase-difference [shuang boshu xiangwei cha] technique for altimetry was first discovered by Chen in 1977 when he was working on a navigational radar-antenna design project. In the technique, a common microwave two-coordinate radar is refitted to convert it into a three-coordinate radar for precise altimetry, useful in target indication radar, antiaircraft warning, navigation, and weather radar. [Summary] [40080134a Beijing ZHONGGUO DIANZI BAO in Chinese 10 Feb 89 p 1]

New Radar System--The model 1A radar developed by the Changzhou [7022 3166] Radio Plant--following land, sea, and electronic-countermeasures testing--recently passed ministry-level certification. This noncoherent radar uses digital tracking frequency-agile [shuzi genzong pinlü jiebian] technology. [Summary] [40080134b Beijing ZHONGGUO DIANZI BAO in Chinese 10 Feb 89 p 1]

Advanced Airborne Radar Research--Noted radar-antenna and radome specialist Du Yaowei [2629 5069 1919] and his associates at the Ministry of Machine-Building & Electronics Industry's Research Institute 14 in Nanjing are currently engaged in research on a "variable thickness airborne early-warning revolving radome" [bian houdu de jizai yujing leida xuan zhao] meeting advanced international standards for the nineties. Several experiments have already been completed. In addition to designing this new radome technology, Du is also working on a satellite ground-station dedicated receiving antenna combining C-band, K-band, and P-band receivers into one spherical bubble hood [paomo zhaozi]. [Excerpts; a full-text translation will appear in an upcoming JPRS report under "Aerospace"] [40080134c Beijing ZHONGGUO DIANZI BAO in Chinese 10 Feb 89 p 3]

National Optics Lab Opened Up--In order to further basic theory and advanced research and development of optics in China, the Chinese Academy of Sciences' Changchun Institute of Optical & Precision Machinery has opened its National Applied Optics Laboratory to the outside world for international cooperation. Nine sub-units--involved in optical design, testing, color optics, ultraprecise diamong machining, optical computing, short-wave studies, and other areas--will be opened up. [Summary] [40080134d Beijing ZHONGGUO DIANZI BAO in Chinese 10 Feb 89 p 3]

Chinese Success Exporting Vacuum-Plating Equipment

40080094a Shanghai JIEFANG RIBAO in Chinese 12 Dec 88 p 2

[Article by Zhang Zhiyuan [1728 1807 6678]: "Vacuum Plating Equipment's Excellent Quality and Reasonable Pricing Draws Attention From Far and Wide"]

[Text] With only some 400 employees, the Dawn Machinery Plant of Shanghai has made the most of its advantages in military industrial production technologies to successfully develop the largest vacuum-plating [i.e., vapor deposition] machinery in China for export to Hong Kong. This plating equipment, which is microprocessor-controlled and which meets international standard of the early 1980's, is priced at only one-half that for similar foreign equipment. It quickly drew the attention of both domestic and foreign vacuum-plating industry interests as soon as it hit the Hong Kong market. The plant recently developed a new piece of equipment that has been ordered by Indonesian business interests.

Vacuum-plating machinery is equipment that requires a very high degree of vacuum, and the Hong Kong and other markets have been dominated by Japanese and American products. The Dawn Machinery Plant has long been involved with large quantities of vacuum equipment for China's satellite and rocket research, and has dared to compete with foreign firms, and in doing so has successfully developed several products that sell for less than similar foreign products. Its vacuum-plating machinery that is of a similar quality with foreign products has allowed China's Hong Kong market share for this sort of product to rise rapidly to 70 percent. The large-scale continuous vacuum-plating machinery manufactured by the Dawn Plant can plate 180 meters each minute, and uses 1,000 tons of plating film annually. It can vapor deposit a layer of extremely fine but strongly adhering metallic film onto various plastic thin films or onto paper, which consequently greatly reduces the amount of metal used. More than 10 plating industry plants in major cities located in Guangdong, Fujian, Henan, Jiangsu, Zhejiang, and Heilongjiang provinces had been planning to import such equipment next year, but upon hearing of this equipment, they immediately dispatched technical personnel to Shanghai to inspect the new plating equipment being manufactured by the Dawn Plant. They are planning to change their intentions and buy the domestic products, which will save much foreign exchange for the state.

Until now, this plant was seen as a small firm in competition with the Japanese and American vacuum technology industries, but it has exported a total of 73 plating machines of different kinds, which have earned 2.5 million U.S. dollars, more than half the amount earned by exports of similar products throughout China.

China's Accelerator Technology Approaches World Class

40080104b Beijing RENMIN RIBAO in Chinese 2 Jan 89 p 3

[Text] According to Professor Xie Jialin [6200 1367 7792], Director of the Chinese Particle Accelerator Society, following the operation of the Beijing electron-positron collider [BEPC], the Lanzhou heavy ion accelerator has also been completed and the synchrotron radiation source in Hefei is near completion. The smooth progress of the three major projects indicates that China's accelerator technology is approaching the state-of-the-art.

Xie said that China has made rapid advances in accelerator development in recent years. The intensity of the BEPC has just been increased by another two orders of magnitudes and the energy of the heavy ion beams in the Lanzhou heavy ion accelerator is also being increased. The construction and installation of the Hefei synchrotron radiation source are approaching the final stages. These three major projects used foreign advanced technology as reference, united the science and technology and industrial resources in China, and overcame a number of key technical difficulties. These achievements have laid a sound foundation for accelerator technology in China and gave China the ability to compete on the international science. In the meantime it also trained and strengthened a mature technical team for accelerator development.

Considerable advances have also been made in the development and application of small accelerators. According to unofficial statistics, there are 170 small accelerators in China and 160 ion injectors.

New developments include an electron window accelerator, a low-power series accelerator, a heavy ion implanter, and an axially coupled standing wave accelerator. Under development are induction linear accelerators, and electron linear accelerators for industrial flaw detection.

In terms of applications, there are more than 70 accelerators in China that are operated for medical uses and the market for industrial radiography is expanding. Industrial radiography centers are being formed in Beijing, Shanghai, and in southwestern, northwestern and northeastern China, and the number of accelerators devoted to industrial flaw detection has exceeded ten.

China's Superconductor Research Described as State-of-the-Art

40080104c Beijing RENMIN RIBAO in Chinese 2 Jan 89 p 3

[Article by Chen Zujia [7115 4371 3946]

[Text] According to experts, China's superconductor research is making in-depth advances and is still leading the world. They also pointed out, however, this field is encountering some common difficulties.

Progress of a national joint effort in superconductor research was reviewed in december 1988 by the Superconductor Technical Expert Committee and the National Superconductor R & D Center.

China has made major advances in recent years in the fabrication of superconductor thin films. Researchers have developed a number of new fabrication techniques and obtained high quality superconducting thin films. They have made yttrium barium copper oxide thin films that achieved a maximum current density of 10^6 amperes per square centimeter at liquid nitrogen temperature. This is close to the current foreign record. The Chemistry Institute of the Chinese Academy of Sciences has used chemical synthesis in the preparation of superconducting films and developed novel techniques.

Sintering of bulk superconductors is a major objective of the Chinese researchers. Bismuth series and thallium series superconductors made in China have stably reached a zero-resistance temperature of 100 K or so, with the highest exceeding 110 K. Eight units including the Physics Institute of the Chinese Academy of Sciences, the Shenyang Institute of Metallurgy, Beijing University, and the Beijing Institute of Nonferrous Metals have prepared yttrium barium copper oxide and bismuth strontium calcium copper oxide superconductors with current flows per square centimeter exceeding 1000 amperes, and a maximum critical current density reaching 2000 amperes per square centimeter. Researchers have also investigated the rolling of ribbons and the drawing of wires and had success. These will prepare for the practical application of superconductors.

Chinese researchers have investigated the mechanisms that prevented higher current density in bulk superconductors both theoretically and experimentally and proposed new interpretations. Some researchers observed for the first time the effects of pinning on the increase of current density and proposed the relationship between antidomain and the critical current density. Others thought that the current density depended upon the cleanliness of the grain boundary, the structure of the grains and the compositions of the materials. Recently, Chinese scientists photographed the surface structure of the superconductors with a scanning tunneling microscope and achieved atomic scale resolution. The results are useful in the microscopic study of the superconductor structures.

In the area of applications, SQUIDs developed by China Institute of Measurements are capable of measuring the magnetic permeability of the weak biological magnetic field of the human body and magnetic materials. Superconducting magnetic shields developed by the Northwestern Institute of Nonferrous Metals, Fudan University, and Central South Industrial University all have their unique features and some have achieved the newest international standards. Researchers at Nanjing University have first developed superconducting high frequency detector, and then started investigating the feasibility of superconducting microwave switches.

Officials said that China has formed a strong united force in science and technology for the superconductivity effort in the fiercely competitive international scene. The team is looking for new breakthroughs.

Research, Implementation of Advance-Synchronizing Error-Detecting System

[Article by Chen Xin [7115 2946], Hu Zhengjia [5170 2973 1367], and Zhang Deyun [1728 1795 2429] of the Xi'an Jiaotong University Department of Computer Science and Engineering; manuscript received 10 Mar 88]

[Excerpts] Abstract

Synchronization techniques are key determinants of the accuracy of bit error detection. This article analyzes the synchronization performance of a foreign-made self-clocking bit error detection technique, discovers that its synchronization holding performance was less than ideal, and suggests a program for improvement. Preliminary theoretical analysis indicates that appropriate increases in the synchronization decision threshold and adoption of time-delay judgment strategies could give this new program a stronger synchronization holding and synchronizing hunting performance. It also has a rather high precision of detection and simple architecture, and is easy to implement. On the basis of this program and the detection requirements for low-speed network transmission channels, a new type of microcomputerized bit error characteristic detection system was implemented. It makes simultaneous measurements of packet error rates and bit error rates according to CCITT recommendations, and for the first time adopts a compressed array format to display and record detailed distributions of bit errors and slips.

Key words: digital communications, bit error rate, synchronization tracking

Chinese Published Information Category Number: TN919.33

0. Introduction

It is common knowledge that the various transmission losses in digital transmission systems can be tied to the effects of bit error characteristics. This makes bit error performance the most basic and

most important index for evaluating the actual performance of digital transmission systems. This also makes research on bit error detection techniques extremely important.

Bit error detection methods usually are divided into two main types, the unattended testing method and the operational testing method[1]. The first requires interruption of normal communication duties, but detection results are more accurate. It is suitable for use in design and production testing and in the installation stage. It is especially suitable for use in large-capacity, long-distance transmission systems. The latter has no or very little effect on communications effectiveness, but the degree of precision in detection is poorer, and it is generally used in system bit error monitoring and alarms. The discussion in this article will be restricted to unattended detection.

The basic methods of unattended detection have been standardized internationally. The transmitting end transmits a specific sequence m and the receiving end makes closed-loop bit-by-bit comparisons of the received input sequence with a locally generated error-free parameter waveform. The key to detection quality lies in the synchronization technique employed. Detection systems with excellent synchronization performance can achieve synchronization quickly and maintain it in a high bit error rate (BER) situation or long bit error time. In other words, two main indices are used to evaluate synchronization performance. The first is synchronization hunting time, referring to the time between loss of synchronization in the system and hunting and re-entering a synchronization state. The second is the synchronization holding time, referring to the time interval between a system entering a synchronized state and a loss of synchronization because of bit error. These two indices determine the precision of bit error detection, and obviously, less is best in the former and more is best in the latter.

The detection method in widest use at the present time is the follow-up synchronization method. It involves an m sequence generation method used at the receiving end which continually monitors the input bit flow. After detecting an input sequence which conforms to this generation method and whose length exceeds the specified threshold L, it decides that it has received error-free PN [pseudorandom noise] code and that its length is a part of m (m $\leq$ L where m is the maximum power value used in the m sequence to generate multiple formats) which is "injected" into the local m sequence generator to serve as a standard for closed-loop synchronized detection.

Reference [2] describes several bit error detection techniques developed in foreign countries. Self-clocking detection techniques have attracted considerable attention because of their excellent performance.

[Passage omitted]

II. Advance-Synchronizing Bit-Error-Detecting Programs

2.1. Working principles

An advance-synchronizing program is an improved program which employs self-clocking detection techniques. Both have identical bit-error-detection principles but differ in the synchronization strategies employed. The principles are illustrated in Figure 3. Three key measures are employed to increase the synchronization hold time and reduce the synchronization hunting time. The first is to increase the synchronization counter's full count value K to make K < m. The second is to add a time-delay component with a delay of τ (τ is a positive integer no greater than K) bit cycles--a shift register with a series of τ. The third is to change the final stage of the bit error register to output a bit error sequence. The goal in increasing K is to lengthen the error-decision code type, which significantly reduces the probability to its generation. It plays a rather apparent role with very obvious benefits. This is very clear from formulas (7) and (8) and the computed examples following them. However, a higher K value may increase synchronization hunting time. To reduce this effect, a time-delay decision synchronization strategy is employed.

Figure 3. Diagram of Advanced-Synchronizing Bit-Error-Detection System Principles

m sequence generator

Synchronization decoder

Synchronization counter

Time-delay register

Bit error register
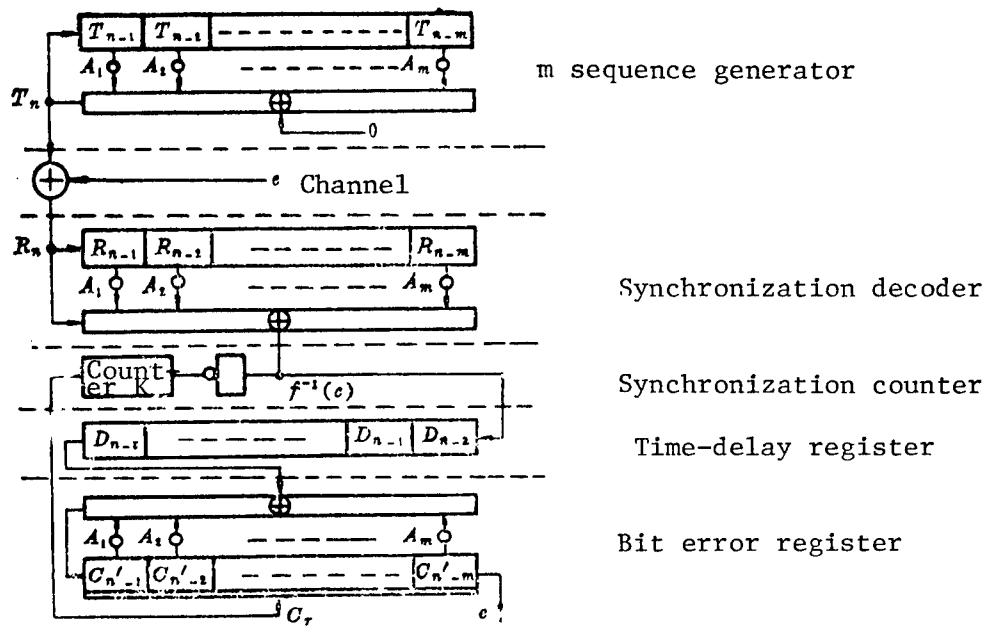
Analysis of the principles of self-clocking detection techniques shows
that whenever a loss of synchronization causes a system to enter the
synchronization hunting process, the system bit error sequence output is
insignificant until synchronization is re-established. The system must
wait until the synchronization counter reaches the K value before the
input sequence it receives is determined to be a correct PN code field,
and it must take measures to synchronize with it. During this period of
time, the system must output an additional (m + K) insignificant bit-
error-detection pulses. To overcome this shortcoming, our program added
a time-delay component. The output sequence from the synchronization
decoder is delayed τ bit cycles. In addition, the bit error output end
is shifted from in front of the bit error register to the end stage.
This causes the output of the bit error register to be delayed by a
total of up to (τ + m) bit cycles relative to the system input in order
to wait for the synchronization counter to make a synchronization
decision. In this way, when the synchronization counter reaches the K
value and the bit error register is cleared, the τ error-free pulses
output by the synchronization decoder arrive just at the right instant.
As a result the system outputs τ + m correct bit-error-detection pulses,
the equivalent of entering a synchronization state in advance by (τ + m)
bit cycles, which attains the goals of reducing synchronization hunting
time and increasing detection precision. Obviously, it is best for τ to
be somewhat larger, and optimum results come when τ = K.

To detect a loss of detection synchronization created by channel slips
or other reasons and increase the reliability of detection, a
synchronization loss detection component is added to an actual working
system. As shown in Figure 4, C_r is the purely 0 end, Z_D is the full
"0" detection end, and P is the counter enabling end. The principles
for detecting a loss of synchronization are: when the synchronization
counter satisfies the value K because of continuous "0" pulses, if the
bit error register is not entirely "0" (that is, the output at the Z_D
end is "0"), a loss of synchronization can be considered to have
occurred. At this time the loss of synchronization detection output end
is "1" and the bit error register is purely 0 and it re-enters
synchronization.

2.2. Synchronization performance analysis

2.2.1 Mean synchronization hunting time

Synchronization hunting time in the advance-synchronizing program is the
period which begins at the instant of a loss of synchronization and ends
when the synchronization counter successfully fulfills the K value and
τ + m bit cycles before the bit error register is purely 0. Advance-
synchronizing principles reduce the total time required for successful
synchronization hunting by τ + m bit cycles. This program uses a state
transfer flow chart method[5] to derive this period of time.

The state transfer flow chart from state A, a loss of synchronization,
to state B, synchronization, is shown in Figure 5. In it, p is the mean
BER (defined as the random bit error), q = 1 - p, and R_i
(i = 0, 1, 2, ..., m) is the system state at the instant of a loss of
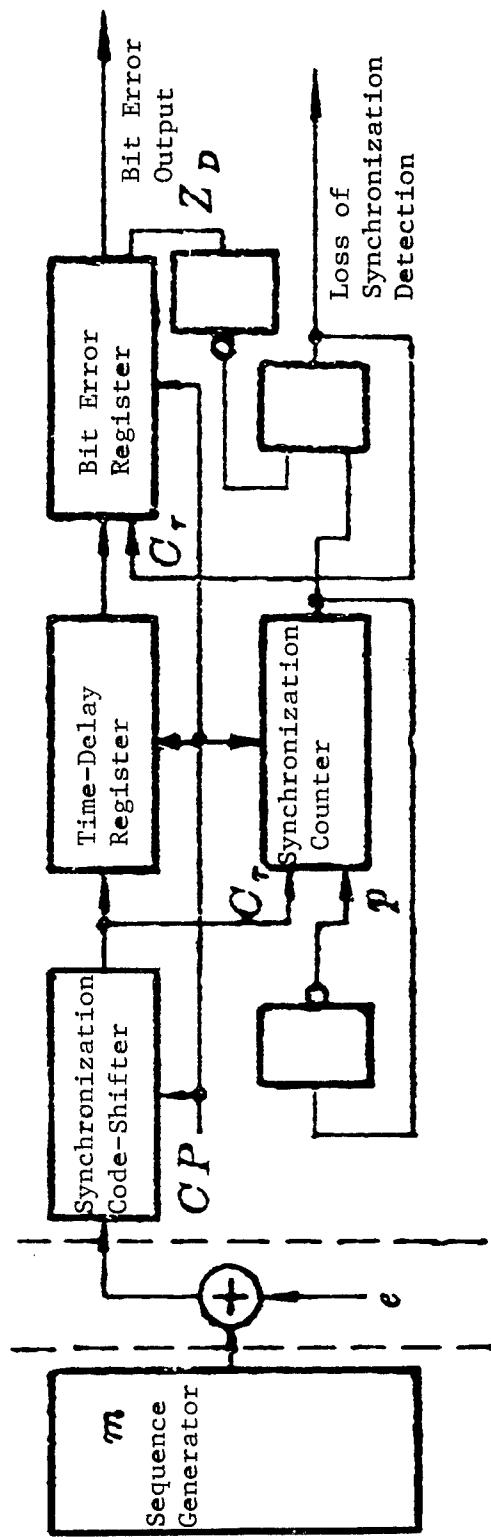
Figure 4. Block Diagram of Advanced-Synchronizing Bit-Error-Detection System Operation

synchronization, indicating that the previous i level of the synchronization decoder has shifted in i error-free bits.

T_j (j = 1, 2, ..., K) indicates that the synchronization counter has received j continuous "0" pulses output by the synchronization decoder. The branches with a traffic volume of $Z^{-(r+m)}$ in Figure 5 are a product of the advance-synchronizing program, and its physical significance is apparent.

Figure 5. Advance-Synchronization Hunting State Conversion Flow Diagram
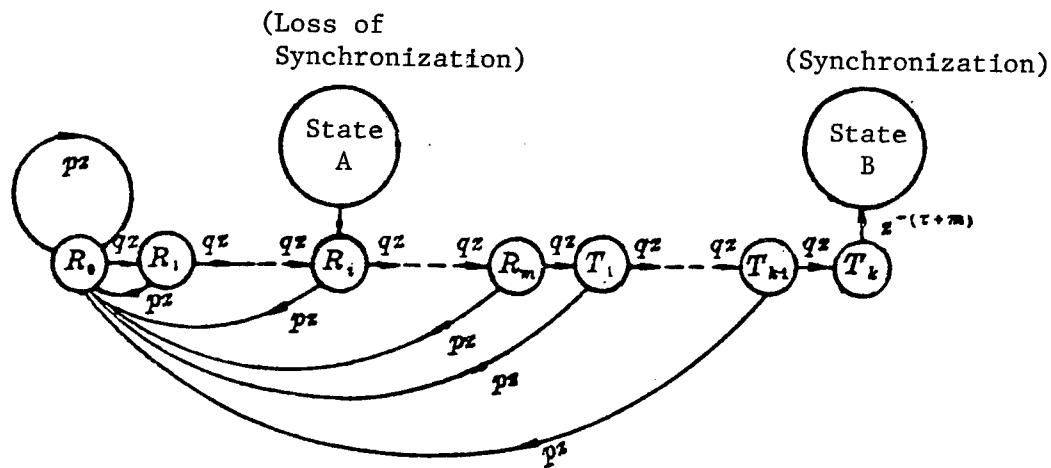
Using Figure 5 and the Mason method, the function $F_{AB}(z, i, \tau)$ from state A a loss of synchronization, to state B, synchronization, can be derived as:

$$F_{AB}(z,i,\tau) = \frac{(qz)^{m+k-i} \cdot \left[1 - pz \sum_{j=0}^{i-1} (qz)^j \right] \cdot z^{-(\tau+m)}}{1 - pz \sum_{j=0}^{m+k-1} (qz)^j} \qquad (9)$$

The mean synchronization hunting time $T_{AB}(i, \tau)$ can be derived from formula (9):

$$T_{AB}(i,\tau) = \frac{dF_{AB}(z,i,\tau)}{dz}\bigg|_{z=1} = \frac{1-q^{m+k-i}}{pq^{m+k}} - (\tau+m)(\text{bit cycles}) \quad (10)$$

The i in the formula is the error-free PN code bit number in the front of the synchronization decoder at the time synchronization is lost. Because of the randomness of the m bits in the synchronization decoder at the time synchronization is lost, it can be considered that the probability of the first i bits being the same as the correct m sequence is $\left(\frac{1}{2}\right)i$, with a mean i of:

$$\bar{i} = \sum_{j=1}^{m} i \cdot \left(\frac{1}{2}\right)^i = 2 - \left(\frac{1}{2}\right)^m \cdot (m+2) \quad (11)$$

Assuming that in formula (10) i = $\bar{i}$, the mean synchronization hunting time is:

$$T_{AB}(\bar{i},\tau) = \frac{1-q^{m+k-\bar{i}}}{pq^{m+k}} - (\tau+m)(\text{bit cycles}) \quad (12)$$

2.2.2 Mean synchronization holding time

It is apparent from the principles of advance synchronization that if an error decision code longer than m + K appears, the system also will lose synchronization τ + m bit cycles in advance. When the K + m value is rather large, however, the extremely small probability of an error decision code appearing means that the synchronization holding time is much greater than τ + m bit cycles, and this effect can be ignored completely. For this reason, merely by changing the 2m in formulas (6) and (7) to K + m, the minimum synchronization holding time still can be estimated roughly according to formula (8).

Table 1 compares the synchronization performance of self-clocking programs and advance-synchronizing programs in various situations when the M-sequence-generated multiformat is 1 + x^5 +x^9. In it, T_{MIN} and R_S were calculated on the basis of f_n = 2.048 Mbits/s and p = 1 x 10^{-2}.

T_{AB}(bit cycles) / Mean Bit Error Rate P / Program		0	1×10^{-3}	5×10^{-3}	1×10^{-2}	5×10^{-2}	$T_{\min}$	$R_s = T_{AB}/T_{\min}$
Self-Clocking	$K=m=9$	16.02	16.19	16.89	17.82	28.21	0.0163s (16.3ms)	1093
——	$K=56$	63.02	65.21	75.04	90.17	538.9	5.7 $\times10^{11}$s	1.58 $\times10^{-10}$
——	$K=\tau=9$	7.02	7.19	7.89	8.82	19.21	0.0163s	541.1
Advance-Synch'z'g	$K=\tau=56$	0	0.21	10.04	25.17	473.9	5.7$\times10^{11}$s (18063yrs)	4.42 $\times10^{-11}$

Table I. Synchronization Performance Chart

In our program, when the m + K value is rather large, the probability of a loss of synchronization due to bit error is extremely close to 0. Thus, when a loss of synchronization is detected, it can be considered to be due to channel slips. This is particularly true when τ = K. If a channel creates a pure slip for an interval of more than m + K bit cycles, then the bit error detection end would not display a bit error, but instead would use the loss of synchronization detection end to indicate the occurrence and location of this type of slip. This is a true indication of a synchronization hunting time of 0 when there are no bit errors. Can this be achieved technically at the present time? By determining the type of slip (repeated or deleted) and bit count, this design is more ideal.

To measure network transmission-channel statistical error laws and use them to design a highly effective error control system to make full use of channel capacity, a type of microcomputerized bit error characteristic detection system based on an advance-synchronizing bit

error detection program was successfully implemented. Its main characteristic is simultaneous measurement of packet error rates and bit error rates on the basis of CCITT recommendations, and the use of compressed array formats to display and record the detailed distribution of bit errors and slips. Use of this format can enable a shift toward achieving new bit error evaluation yardsticks[6].

III. Conclusion

The advance-synchronizing bit error detection program has rather good synchronization performance and can greatly increase the detection precision of bit error detection instruments in an adverse bit error environment. Moreover, its architecture is simple, and hardware and software are easily used to attain a very broad working frequency range. The microcomputerized bit error characteristic detection system implemented using this program has excellent operational results and met design requirements. Besides simultaneous measurement of packet error rates and bit error rates on the basis of CCITT recommendations, it also can detect and record the actual interlocked distribution of a channel. It has definite theoretical, economic, and applicational value in computer network development, digital communications, and other sectors.

References

1. Performance Analysis of Digital Transmission Systems (translated from COMMUNICATIONS INTERNATIONAL 1984 Vol. 11, No. 1), in WUXIANDIAN TONGXIN CANKAO [REFERENCE MATERIALS ON RADIO COMMUNICATIONS], No 4, 1986 pp 44-48. (Translator's name not given).

2. Zhu Jiang [2612 3068], Cutting-In-Traffic Measurement of Bit Error Rates, SHUZI TONGXIN [DIGITAL COMMUNICATIONS], No 3, 1981 pp 1-8.

3. L. C. Schooloy and T. W. McCurnin, Measurement of Bit Errors in Data Transmission Systems, IEEE TRANSACTIONS, Vol COM-24, No 1, January 1976 pp 144-146.

4. Ji Keping [0370 0344 1627] and Xu Jinqi [6079 6855 3825], A Simple Design for an Anti-Fading Bit Error Detection Instrument, WUXIANDIAN TONGXIN JISHU [RADIO COMMUNICATIONS TECHNOLOGY], No 2, 1985 pp 41-47.

5. R. W. Sittler, Systems Analysis of Discrete Markov Processes, IRE TRANSACTIONS ON CIRCUIT THEORY, Vol CT-3, December 1956 pp 257-266.

6. Hiruma Shigeru and Shinohara Mamoru, A New Bit Error Evaluation Yardstick, SHISETSU [in Japanese], No 7, 1986 pp 111-116.

Coordinated Development of Microwave, Optical Communications

[Article by Zhang Xu [1728 3563], Scientific Council of the Chinese Academy of Sciences and professor at Jiaotong University]

[Text] Introduction

Over the years, China has combined wired communications and wireless communications to establish an economically sound domestic communications network. As new technologies become available, [coaxial] cables are being replaced by optical fibers in wired communications, and microwave satellite communications and microwave relay communications have become the primary mode of wireless communications. It is inevitable that the future communications network in this country will consist of elements of microwave communications and optical communications. In view of the unique features of microwaves and light waves, neither one will be able to dominate the other. Thus, it is important to closely coordinate the development of microwave and optical communications; it is also important to promote China's domestic communications industry along with its broadcast industry. This should be our basic policy in planning China's future communications network.

It is generally believed that the global trend of future information network is toward digitization. Newly installed switching units are all [stored] program controlled (SPC); by the year 2000, information transmission for broadband integrated services digital networks (B-ISDN) will primarily use optical fibers, satellite communications will become secondary, and microwave relay communications will only play a minor role. Although China has a firm policy to pursue new technologies, we should follow a path which is consistent with China's social and economic conditions instead of blindly adopting the methods of other industrialized nations. A realistic plan will allow the use of analog communications for some time to come while gradually increasing the use of digital communications; it will also allow the coexistence of SPC switching and cross-bar switching. The use of coaxial cables will diminish, but balanced cables will continue to be in use until the fiber-optic and PCM [pulse code modulation] manufacturing industry reaches a mature stage to ensure the quality and reliability of fiber-optic transmission systems. In the near term, we shall fully exploit the

potential of communications satellites launched by this country and Chinese-built ground stations and digital microwave facilities to develop our own satellite communications networks and microwave relay networks. The purpose of this article is to present a coordinated plan for developing satellite communications, microwave communications, and optical communications in this country. Constructive comments from colleagues in the communications community are welcome.

Development of Satellite Communications

The international telecommunications satellite INTELSAT-V A has already been in operation for some time, and INTELSAT-VI is expected to be launched soon. The new satellite will have more transponders, larger capacity, a higher degree of digitization, an improved antenna, and enhanced on-board processing capability. China's capability of launching geosynchronous satellites is well known around the world. In the near future, domestic communications and television broadcasting will increasingly rely on our own communications satellites.

In the near term, domestic satellite communications and broadcasting systems will primarily be used for analog telephone and television transmission, with a small fraction used for data transmission. The use of PCM digital telephone transmission is expected to gradually increase. Most analog telephone communications systems use frequency-division multiplexing and frequency modulation (FDM/FM) or compounded single sideband (C-SSB); some use single channel per carrier (SCPC). Point-to-multipoint communications systems use frequency-division multiple access (FDMA); television broadcasting systems use the Chinese standard PAL-625/50; and digital communications systems use quadrature phase shift keying (4PSK) [also known as QPSK], time-division multiplexing (TDM), and time-division multiple access (TDMA), with a small fraction using spread-spectrum communications and code-division multiple access (SS/CDMA). The propagation time delay in satellite communications can be as long as half a second, which produces undesirable echoes in telephone communications or data transmission. Fortunately, this problem can be solved by using VLSI echo cancelers.

The frequency range used in domestic satellite communications for the near future will continue to be mainly C-band (6/4 GHz); however, the Ku-band (14/12 GHz) will soon be added to allow increased power and smaller antenna size. In the past, the A-standard size for a ground station parabolic antenna was 30 m; but today, the requirement has been reduced to 10~18 m, and some antennas are only 6 m in diameter. Other ground stations have no transmitting equipment; they are only used for television reception. Another type of low-cost, miniature ground station is especially designed for low-bit-rate data transmission in a dedicated satellite communications network.

Most satellite antennas used for communications purposes are pencil-beam antennas, so power can be focused on a specific region on earth; also, various frequency reuse techniques should be implemented as much as possible. Satellite on-board broadcast antennas, on the other hand, generally have broad beams in order to cover a large area. The

communications satellites recently launched in this country are not equipped with complicated microprocessors, switching units, or channel selectors in order to ensure a high degree of reliability. The ground stations, on the other hand, should incorporate advanced technologies as much as possible, and should be equipped with a sufficient number of computers and digital signal processors. In fact, most Chinese-built ground stations are already equipped with solid-state low-noise amplifiers, surface-acoustic-wave (SAW) IF 70-MHz filters, and extended threshold demodulators.

The Past and Future of Microwave Relay Communications

Although microwave relay communications is no longer considered new technology, it is mature and reliable, and the current analog systems are being converted to digital systems. In fact, even in developed countries, almost half of the long-distance telephone transmission and all of the television transmission are still using microwave relay circuits. This country also established its microwave network a long time ago, and has developed the capability to design, manufacture, and install microwave circuits. This mode of communications has many advantages, and should continue to be expanded.

In microwave relay communications, frequency-division multiplexing and frequency modulation (FDM/FM) is generally used for both analog telephone and analog television systems. The frequency range used in long-distance relay networks is 4~6 GHz, and the distance between relay stations in hilly regions is approximately 50 km. With the conversion to digital systems, the operating frequency may be increased to 11~15 GHz; in particular, the frequency range for short-distance circuits may be increased to 20~40 GHz, and the distance between relay stations will correspondingly be reduced to 25~30 km. In the early days, the modulation used for digital signals on a microwave carrier was phase shift keying (4PSK or 8PSK), and was limited to low-bit-rate (34 Mb/s) [DS3] transmission. Later, quadrature amplitude modulation (16 QAM or 64 QAM) was used to accommodate medium-bit-rate (140 Mb/s) [DS4] transmission. Recent research efforts have been focused on the more complicated N-ary [modulation] system (256 QAM), which can be used for high-bit-rate (400 Mb/s) transmission; but it requires a carrier-to-noise ratio (C/N) or more than 30 dB. The N-ary system has a bandwidth of 40 MHz, and a frequency utilization rate as high as 10 b/s/Hz, which is the highest utilization rate achievable today in any form of communications. In short, the current trend of development in microwave-relay digital communications is to raise the transmission rate of each carrier so as to increase the frequency utilization rate, even at the expense of reduced power efficiency. The main objective is to achieve higher C/N and reduce interstation distance. It is believed that the maximum transmission rate for microwave digital communications is about 400 Mb/s; thus, from this point of view, microwave communications is inferior to optical communications.

The quality of microwave relay communications may also deteriorate due to multipath propagation, causing a fading in frequency selectivity, particularly over smooth water surfaces. This is another shortcoming of microwave relay communications compared to fiber-optic communications. In

order to prevent fading, effective measures such as frequency-diversity and antenna-diversity reception, forward error correction, and adaptive cross-polarization canceling can be implemented. With the development of new technologies such as very-large-scale integration (VLSI), millimeter-wave integrated circuits (MMIC), surface acoustic wave (SAW) [devices], digital signal processors (DSP), and solid-state microwave active devices (GaAs-FET), significant progress has been made in the design of microwave relay circuits--smaller size and much lower power consumption. Another key issue in designing a microwave relay network is the selection of relay routes; in general, it is desirable to choose a path through hilly regions and construct relay stations on top of mountain peaks. If possible, the routes should avoid lakes and tall buildings; therefore, microwave communications should not be used in the vicinity of large cities.

The Enormous Potential of Fiber-Optic Communications

Since the discovery of the capability of high-purity quartz optical fibers to transmit information, fiber-optic communications technology has experienced growth: from short wavelength to long wavelength, from multimode optical fibers to single mode optical fibers; fibers with core diameter of 8 μm and cladding of 125 μm have been developed. The third-generation 1.3 μm conventional single-mode fiber-optic systems ($\lambda_0 = 1.3$ μm) are being used extensively today, and they are being replaced by the fourth-generation 1.55 μm systems. In the new systems, the optical fiber loss will decrease from 0.35 dB/km to 0.20 dB/km, and the conventional single-mode fibers will be replaced by single-mode fibers with zero dispersion shift ($\lambda_0 = 1.55$ μm).

In this low-loss, low-dispersion window of 1.45 μm ~ 1.65 μm, the bandwidth can be as large as 25 THz. Figuratively speaking, a single fiber can transmit a sufficiently large number of bits of information to contain the entire contents of the world's largest library in 20 seconds; or it can carry the conversations of China's entire population of one billion people simultaneously. This illustrates the enormous transmission capacity of optical fibers. In a laboratory demonstration, an optical fiber was able to transmit 50,000 channels of digital telephone signals at a bit rate of 4 Gb/s over a distance of 100 km. If a metallic coaxial cable is used to transmit 10,000 channels of analog telephone signals or data signals at a bit rate of 400 Mb/s, then a relay station must be installed every 1.6 km. Thus, with optical fibers, the bit rate can be increased by one order of magnitude and the relay distance can be increased by two orders of magnitude. Many developed countries have announced that they will discontinue the production of coaxial cables and replace them by optical fiber cable. Optical fiber has sufficient capacity to transmit all forms of digitized information including voice, data, and images; undoubtedly it will become the ideal transmission medium for future broadband integrated services digital networks (B-ISDN). Its potential capability can satisfy the needs of the rapidly growing information industry of the 21st century.

The success of fiber-optic communications is also attributed to the rapid development of photonic devices, particularly the II-V family of semiconductors AlGaAs and InGaAs. There are for types of photonic devices; light emitting diodes (LED), laser diode (LD), light-detection photodiodes

(PIN), and avalanche photodiodes (APD); in recent years, both the performance and quality of these devices have improved significantly. In particular, the 1.55 μm single-frequency laser diode uses a dual-channel planar buried heterostructure with distributed feedback (DCPBH-DFB) to improve the output stability; it also has other desirable properties such as narrow line width, tunability, and small frequency fluctuations. Recently, based on the experience of microelectronic circuits, photonic devices and electronic devices have been integrated on the same chip to form what is called the optical electronic integrated circuit (OEIC). This key technology can lead to optical terminals with smaller size and improved reliability.

There are four areas of research in fiber-optic transmission systems: conventional communications, coherent communications, multichannel carrier communications, and optical amplification communications. In a conventional communications system which uses direct detection, signals are transmitted on a 1.55 μm dispersion-shifted optical fiber; its maximum bit rate is 10 Gb/s and the maximum transmission distance is 80 km. In a coherent communications system which uses heterodyne detection, one can achieve 4 Gb/s and 155 km with continuous phase [frequency shift keying] CPFSK; good results can also be obtained with conventional FSK and differential PSK (DPSK). Since coherent communications greatly enhances frequency selectivity, the optical fiber can accommodate a larger number of carrier channels and a smaller frequency separation, thus greatly increasing the overall transmission capacity. Furthermore, by tuning the laser local oscillator, one can selectively receive any one of the optical carriers. It is also possible to achieve a bit rate of 400 Mb/s and a regenerative-repeater spacing of 372 km by installing four recently-developed laser amplifiers along the relay path using FSK and heterodyne detection.

The practical application of fiber-optic communications began as a means of intracity communication, and was later extended to long-distance transmission and undersea-cable transmission; in the future, its application may be further extended to intracity customer networks and local area networks around the country. Fiber-optic circuits are also widely used in many dedicated communications systems. Unfortunately, the optical fibers produced in this country do not meet the quality and reliability requirements for fiber-optic communications. Although we have imported fiber-optic circuits from abroad, it is not a long-term solution of the large demands of fiber-optic communications are to be met. In addition, because of the underdeveloped status of China's overall communications industry and the slow progress in digital communications, it is premature to initiate an effort at full-scale development of fiber-optic communications at the present time. This is one of the main reasons for continuing to rely on satellite communications and microwave relay communications.

Concluding Remarks

At the present time, satellite communications still plays a major role in international and domestic communications as well as in television transmission and broadcast. While we should continue to cooperate with INTELSAT and try to maintain our favorable status in leasing its

transponders, we should also actively support China's own effort to launch the next-generation communications satellites in order to accelerate the development of China's domestic communications and television industry. Fiber-optic communications is a long-term issue that will affect the future construction of communications networks in this country. Although it can satisfy the needs of the rapidly growing digital communications industry, it is imprudent to devote our current resources to the full-scale development of this technology or to rely heavily on foreign imports. Rather, we should concentrate our current resources to the full-scale development of China's own fiber-optic manufacturing capability, particularly in the areas of optical fibers, optical cables, photonic devices, and PCM integrated circuits. Large-scale development of fiber-optic communications is possible only after a mature production capability has been established to ensure product quality and low production cost. At the present stage, the sensible approach is to promote microwave relay communications; specifically, digital microwave relay communications, which can serve as an alternative to fiber-optic communications in the foreseeable future, and analog microwave relay communications can be used for transmitting television programs between large cities. Therefore, we should adopt a policy of coordinated development of microwave relay communications and optical communications with equal emphasis on communications and broadcasting, and with parallel development in both public communications and dedicated communications. Once we have an overall understanding of these general principles, we can then begin the process of detailed planning, verification, and analysis to achieve the best results.

Table 1. Comparison of Microwave Communication and Optical Communication

| | Microwave communications | | Optical communications |
	Satellite communications	Microwave relay communications	Fiber-optic communications
Transmission distance	Covers large area, can be used for international and interprovince long-distance communications; suitable for communications with remote regions	Can be used for interprovince and intraprovince medium-range communications; separation between relay towers less than 50 km	Can be used for interprovince, intraprovince, intracity or local area communications over any distance; separation between relay towers 40 km, may be extended to 200 km in the future
Bandwidth or bit rate	Transponder bandwidth 36~72 MHz	Intermediate bit rate 140 Mb/s	Enormous capacity with high bit rate 565 Mb/s~2 Gb/s

[Continuation of Table 1]

| | Microwave communications | | Optical communications |
	Satellite communications	Microwave relay communications	Fiber-optic communications
Network construction	Ground station or miniature ground station can easily be installed	Terminal stations and relay stations can be easily installed; route selection may be time-consuming	Installation of long-distance circuits is costly and time consuming; intracity circuits are easy to install
Point-to-point or multipoint	Address-based communications, domestic broadcasting	Point-to-point communications	Point-to-point communications
Stationary or mobile	Stationary communications, but address can be easily changed; can also be mobile communications	Stationary communications	Stationary communications
Analog or digital	Mostly analog telephone or television, with new digital communications capability	Originally analog communications; new digital communications capability being implemented	Mainly used for digital communications, with limited applications in short-distance analog television transmission
Television	Suitable for analog television broadcasting	Suitable for analog television transmission	Future digital television transmission, can be used for CATV
Customer hookup	Television reception via customer-installed antenna; communications via municipal telephone network	Via municipal telephone network	Via municipal telephone network
Communications security	Digital communications using encrypted code	Digital communications using encrypted code	Cannot be intercepted, no leakage, highly secure

[continued]

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[Continuation of Table 1]

	Microwave communications		Optical communications
	Satellite communications	Microwave relay communications	Fiber-optic communications
Electromagnetic interference	May interfere with ground-based micro-wave circuits	May be subject to electromagnetic interference; also may interfere with other microwave circuits	Not subject to electromagnetic interference; does not inter-fere with other communications
Signal fading	Raindrops will cause signal fade	Multipath propaga-tion may cause fade in selectiv-ity, which can be minimized by using diversity reception	Not subject to fade
Propagation delay	Round-trip delay of the order of half a second; requires echo canceler	Almost no delay	Almost no delay
Frequency utilization rate	4PSK~2b/s/H	256 QAM-10b/s/Hz, highest efficiency	100 channel FDM 10b/s/Hz, low efficiency
Power efficiency	Subject to satellite weight constraint, requires high power efficiency	Capacity may be increased at the expense of power efficiency and re-duced separation between relay towers	Subject to fiber-optic nonlinearity constraint
Major components	Requires high power level, still uses electronic vacuum tubes	Solid state micro-wave devices	III-VT semi-conductor devices
Life	Satellite designed life approximately 10 years		Life of under-ground optical cables 20~30 years
Communications	Fee independent of distance	Fee depends on distance	Fee expected to decrease in the future

Table 2. Coordinated Use of Microwave and Optical Communications Systems

| | | Microwave communications | | Optical communications |
		Satellite communications	Microwave relay communications	Fiber-optic communications
International communications	Telephone and data communications	International communications satellite transponders	--	Future trans-oceanic optical cables
	Television transmission	Analog television	--	Future digital television transmission
Domestic public communications and broadcasting	Nationwide interprovince trunk lines	Domestic satellites	--	Step-by-step construction of future B-ISDN
	To remote regions	Domestic satellites offer best approach	Postpone consideration until later	Postpone consideration until later
	Intraprovince trunk lines	--	Digital microwave system to be constructed immediately	Step-by-step construction
	Intracity, interbureau circuits	--	--	Start construction immediately
	Intracity customer at work	--	--	Future construction of B-ISDN
	Farm and village circuits	--	Partial construction	Overhead optical cables
	Sea coast and island	--	--	Shallow water optical cables
	Television broadcasting	Analog television broadcasting	--	--
	Television transmission	--	Analog television transmission	Future digital television transmission
Domestic dedicated communications	Railroad	Between regional centers	Medium range	Step-by-step construction
	High-voltage transmission line	--	--	Start construction immediately
	National enterprise	Between regional centers	Medium range	Partial construction
	Television station	--	--	Start construction immediately

[Continuation of Table 2]

| | | Microwave communications | | Optical communications |
		Satellite communications	Microwave relay communications	Fiber-optic communications
[cont'd]	Local area network (LAN)	--	--	Coordinated construction together with coaxial cable
	Television monitoring network	--	--	Start construction immediately
	CATV	Shared use of antenna	--	Coordinated construction together with coaxial cable

Error Probability Approximation for Synchronous Code Division Multiplexing System

[English abstract of article by Wu Zhongyi [0702 0022 0001], Xing Xiaolei [6717 2556 4320], and Zhang Naitong [1728 0035 6639] of the Communications Engineering Teaching and Research Section]

[Text] A centralized mobile satellite communications system consists of the relay satellite, the satellite ground station, and mobile users. In order to meet the ever-increasing communications needs of mobile users, this paper presents a method of using the broadcasting channel of a synchronous code-division multiplexing system in the outbound link between the ground station and mobile users so that the utilization efficiency of the system can be increased. The formulae for calculating the error probability of the multiplex system are then derived. Compared with the case of a single channel, the error probabilities in the case of three, five, and seven channels in various signal-to-noise ratios are given; computer simulation is carried out.
Key words: spread-spectrum communications; mobile communications; code-division multiplexing; communications network.

References:

[1] N. Abramsen, "Development of the ALOHANET," IEEE Trans. Inform. Theory, Vol IT-31, No 2, pp 119-23, 1985.
[2] J.Y.N. Hui, "Throughput Analysis for Code-Division Multiple Accessing of the Spread-Spectrum Channel," IEEE J. Select. Areas Commun., Vol SAC-2, No 4, pp 482-86, 1984.
[3] D. Raychaudhuri, "Performance Analysis of Random-Access Packet-Switched Code Division Multiple Access Systems," IEEE Trans. on Commun., Vol COM-29, No 6, pp 895-901, June 1981.
[4] R.C. Titsworth, "A Boolean-Function-Multiplexed Telemetry System," IEEE Trans. on SET, pp 42-45, June 1963.
[5] D.L. Durst, "Results of Multiplexing Experiment Using Walsh Functions," Symp. on Applications of Walsh Functions, 1972, pp 82-88.
[6] R.C. Dixon, "Spread Spectrum Systems" (Chinese edition), Trans. by Wang Shouren [3769 1343 0088] et al., National Defense Publishers, 1984.
[7] L.B. Milstein, "Theory of Spread-Spectrum Communications--A Tutorial," IEEE Trans. on Commun., Vol COM-30, 1982, No 5.
[8] Wu Zhongyi, "Pseudo-Random-Number Sequence Technology," Harbin Institute of Technology Publishers, 1986.

Briefs

Optical Time-Domain Reflectometer Developed--A single-mode, long-wavelength optical time-domain reflectometer developed by the Ministry of Posts & Telecommunications' Beijing Instrument & Meter Research Institute recently passed ministry-level technical certification. This key equipment for quality testing in fiber-optic circuits meets international standards of the mid eighties.
[Summary] [40080133a Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese No 1, Jan 89 p 47]

Fiber-Optic Passive-Devices Technology--As arranged by the State Science and Technology Commission and the Ministry of Machine-Building & Electronics Industry, the Shanghai Transmission-Line Research Institute recently completed a project involving China's first importation of technology to manufacture fiber-optic passive devices. Included in the project are: a testing laboratory for fiber-optic fused-biconical-taper [couplers], a testing lab for precision optical machining of fiber-optic connectors, a machining lab for precision grinding and cutting, and two production lines for single-shift yearly output of 9000 1.3-micron-wavelength 2x2 single-mode fiber-optic couplers and single-shift yearly output of 5000 APT-1.78 single-mode fiber-optic connectors.
[Summary] [40080133b Beijing ZHONGGUO DIANZI BAO in Chinese 31 Jan 89 p 1]

New Satellite Tracking System--The computer-controlled satellite-earth-station 13-meter bipolar antenna tracking system developed by the Zhongshan Group's Nanjing Electronic Technology Research Institute (Institute 14) was recently certified by the Ministry of Machine-Building & Electronics Industry. This system for tracking communications satellites is controlled by a special-purpose single-board microcomputer and provides service 99.95 percent of the time-- 0.015 percent higher than the international specification--as tested under harsh conditions in Xinjiang, Shaanxi, and Gansu Provinces. [Summary]
[40080133c Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 6, 8 Feb 89 p 2]

New Fiber-Optic, Optoelectronic Products--Six new achievements of the Ministry of Machine-Building & Electronics Industry's Research Institute 44, a national leader in developing optoelectronic products, recently passed technical certification. Included are the following four products: the GT5461T single-mode fiber-optic fully hermetic coupling germanium avalanche photodiode, used in fiber-optic communications, fiber-optic television transmission, and fiber-optic broadband detection; the GT4560J fiber-optic coupling indium-gallium-arsenide/ indium-phosphide preamplifier package, used in long-wavelength PCM [pulse code

modulation] digital fiber-optic communications systems, broadband-frequency-response PFM [pulse frequency modulation] analog fiber-optic transmission systems, high-speed fiber-optic transmission systems, and fiber-optic sensor systems; the GF 9410U gallium-arsenide light-emitting diode; and the GT5650U silicon photosensitive triode. These last two devices are critical components in remote-controlled transceiving equipment. [Summary] [40080133d Beijing ZHONGGUO DIANZI BAO in Chinese 10 Feb 89 p 1]

Military Secure Communications Unit--China's independently developed 8-line digital secure radio communications-relay unit [jieli tongxin ji], which comes with a broadband antenna-splitting device, passed certification in 1988 and is now in batch production at the PLA's Plant 6905. This low-power frequency synthesis system, which uses digital-style direct frequency display and keying-method frequency adjustment equipment [dai shuzi shi pinlü zhijie xianshi he jiankong shi pinlü tiaozheng zhuangzhi], is an original idea in domestic design of small transceivers. It can be carried on the back and is suitable for use in harsh outdoor conditions. [Summary] [40080133e Beijing ZHONGGUO DIANZI BAO in Chinese 10 Feb 89 p 2]

New Fiber-Optic Systems--The "Optical Waveguide Fiber Modem System" and "OPCO Optical-Waveguide-Fiber Ring Network" developed by Beijing Science & Engineering University lecturers Yang Yang [2799 2254], Fang Wei [2455 0251], and others were certified a few days ago. Hardware for these systems, which include international-standard communications interfaces, was developed in over two years of experimentation and tested by the Ministry of Posts & Telecommunications' Communications Measurement Center to certify it to early eighties international standards. [Summary] [40080133f Beijing GUANGMING RIBAO [GUANGMING DAILY] in Chinese 13 Feb 89 p 2]

Stabilized Light Source--The WG-1 stabilized light source developed by Research Institute 44 of the Ministry of Machine-Building & Electronics Industry meets advanced international standards for the eighties. Used in fiber-optic communications systems for measuring losses and in fiber-optic sensors, this light source has the following specifications: instantaneous stability (at any temperature between 5 and 35°C for one minute) is less than 0.005dB, prolonged stability (at any temperature 5-35°C for 4 hours) is less than 0.05dB, and rated operating temperature range is 0-40°C. The values for instantaneous stability and prolonged stability both exceed those for recent Japanese products of like kind. [Summary] [40080133g Beijing ZHONGGUO DIANZI BAO in Chinese 14 Feb 89 p 3]

Satellites to Improve Railway Communications--China's railway telecommunications will be improved with a satellite data communications network that will be completed soon, today's OVERSEAS EDITION of the "PEOPLE'S DAILY" reports. The project, the first step in modernizing China's railway telecommunications, is designed to link the four satellite ground stations at railway offices in Beijing, Urumqi in Xinjiang Uygur Autonomous Region, Lanzhou in Gansu Province, and Liuzhou in the Guangxi Zhuang Autonomous Region. The Beijing station is designed to link the three other stations with China's railway headquarters--the Ministry of Railways. [Text] [40100036b Beijing XINHUA in English 1313 GMT 24 Feb 89]

Studies of Photochemical Reduction of $UO_2(NO_3)_2$ in 30 Percent TBP-Kerosene Solution

[English abstract of article by Xu Xiangrong [1776 0686 2837], et al., of the Institute of Atomic Energy, Beijing]

[Text] The photochemical reduction of $UO_2(NO_3)_2$ and the production of HNO_2 in a 30 percent TBP-kerosene solution have been investigated using an argon ion laser with a 488 nm monochromic beam, and the effects of some factors on the quantum yield have also been studied. The main degradation products of TBP in the photochemical process have been detected to be DBP and butyl aldehyde, while nitrous acid is also found in the TBP organic solution at higher temperatures (greater than 30°C). The quantity of nitrous acid is proportional to the power of the light and the concentration of uranyl nitrate, while it decreases with the increased concentration of nitric acid at higher acidities. Possible mechanisms of the photochemical reaction are proposed.

References

1. Bell, J.T., et al., J INORG NUCL CHEM, Vol 36, 1974 p 1575.
2. Bell, J.T., et al., J INORG NUCL CHEM, Vol 37, 1975 p 1469.
3. Bell, J.T., et al., J INORG NUCL CHEM, Vol 37, 1975 p 2529.
4. Bell, J.T., et al., J INORG NUCL CHEM, Vol 36, 1974 p 2561.
5. Xu Honggui, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 5 No 4, 1983 p 266.
6. Yin Yunfu, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 6 No 3, 1984 p 125.
7. Zhang Xianye, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 7 No 3, 1985 p 141.
8. Zheng Chengfa, et al., APPLIED LASERS, Vol 2 No 3, 1982 p 40.
9. Lu Zhiren, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 3 No 4, 1982 p 161.
10. Rofer-Depoorter, C.K., et al., J INORG NUCL CHEM, Vol 39, 1977 p 631.
11. Depoorter, G.L., et al., J INORG NUCL CHEM, Vol 40, 1978 p 1895.
12. Rofer-Depoorter, C.K., et al., J INORG NUCL CHEM, Vol 41, 1979 p 215.

13. Wang Tongsheng, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 6 No 2, 1984 p 83.
14. Kang Xihui, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 6 No 1, 1984 p 6.
15. Woodhend, J., AERE-3432, 1960.
16. Geng Yongqin, et al., JOURNAL OF NUCLEAR AND RADIOCHEMISTRY, Vol 1 No 1, 1979 p 68.
17. Xu Xiangrong, et al., "Reaction Between U(IV) and Nitric Acid and Nitrous Acid in 30 Percent TBP Kerosene Solution," (Publication Pending).
18. Stieglitz, Verlag, Chemie, Gmbh, D-6940, Weinheim, 1982.

Extraction Equilibrium of Uranium (VI) from Phosphoric Solution with HDEHP, TOPO in Cyclohexane

[English abstract of article by You Jianzhang [1429 1696 4545], et al., of the Department of Nuclear Science, Fudan University, Shanghai]

[Text] The extraction equilibrium of uranium (VI) from a phosphoric acid solution with HDEHP and TOPO in cyclohexane has been investigated to examine the effects of extractant concentration, hydrogen ion concentration and temperature on the extraction of uranium (VI). The experimental results suggest that the composition of the synergistic complex species is $UO_2(HA_2)_2 \cdot TOPO$, and that the extraction equilibrium constant β_{21} is $10^{9.52}$ at 30°C. In addition, the thermodynamic functions of the extraction reaction (ΔG, ΔH, ΔS) and the infrared spectra of the synergistic complexes have been determined.

<div align="center">References</div>

1. Blake, C.A., et al., PROCEEDINGS OF THE 2ND INTERNATIONAL CONFERENCE ON THE PEACEFUL USE OF ATOMIC ENERGY, Vol 28, 1958 p 289.
2. Kennedy, J., et al., J INORG NUCL CHEM, Vol 19 Nos 1/2, 1961 pp 142-155.
3. Sato, T., J INORG NUCL CHEM, Vol 26 No 2, 1964 p 311.
4. Bunus, Florin T., et al., J INORG NUCL CHEM, Vol 40, 1978 p 117.
5. Hurst, F.J., et al., PROCESS DES DEV, Vol 11, 1972 p 122.
6. Hurst, F.J., Society of Mining Engineers, AIME, Vol 262, Sep 1977 p 240.
7. Peppard, D.F., J INORG NUCL CHEM, Vol 1, 1958 p 231.
8. (USSR) Moskvin, A.N., "Coordination Chemistry of Actinide Elements," Nuclear Power Press, 1984 p 83.
9. Wang Wenqing, et al., CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING, Vol 2 No 2, 1982 p 165.

Hole Subbands, Optical Transitions of Superlattices in Magnetic Field

[English abstract of article by Xiang Jinzhen [7309 6855 4176] of the Department of Physics, Qinghua University; Xia Jianbai [1115 1696 4101] of the Institute of Semiconductors, Chinese Academy of Sciences]

[Text] Hole subbands and optical transitions of superlattices in a magnetic field are calculated based on the Luttinger-Kohn effective mass theory. The method of calculation is described in detail, and the dependence of Landau energy levels on magnetic fields and well widths is presented. It is found that when the magnetic field or well width increases, the mixing of heavy and light holes becomes obvious, with only the three lowest states retaining their original heavy hole characteristics. It is also found that the third light hold subband is necessary in order for the solutions to converge. The magnetic-optical transition probabilities and the effective masses of cyclotron resonance are discussed.

References

1. Rogers, D.C., Singleton, J, Nicholas, R.J., PHYS REV, Vol B34, 1986
    p 4002.
2. Yang, S.R. Eric, Broido, D.A., Sham, L.J., PHYS REV, Vol B32, 1985 p 6630.
3. Tang Hui, et al., SEMICONDUCTOR JOURNAL, Vol 8, 1987 p 1.
4. Luttinger, J.M., PHYS REV, Vol 102, 1956 p 1030.
5. Hess, K., et al., "Proceedings of the VIII International Conference on the
    Physics of Semiconductors," 1976 p 142.

Simple Approach to Calculation of Force Constants of Semiconductors--
Application to Study of Phonons at GaAs(111)-2 x 2 Surface

[English abstract of article by Lin Zijing [2651 1311 2417], et al., of the Center for Fundamental Physics, University of Science and Technology of China, Hefei]

[Text] An analytical expression for the force constants of semiconductors with arbitrary hybridization is derived by using the bond orbital approximation to simplify the calculation of the electronic band structure energy of the system. This method is shown to be simple and effective by a comparison between the theoretical calculation and the experimental results on phonon dispersion curves of several materials. When applying this method to the study of phonons at the GaAs(111)-2 x 2 surface, the dispersion curves of phonons that are strongly localized at the surface are obtained.

References

1. Weber, W., PHYS REV, Vol B15, 1977 p 4789; Kane, E.O., PHYS REV, Vol B31, 1985 p 7865.
2. Kunc, K., Martin, R.M., PHYS REV, Vol B44, 1981 p 2081; PHYS REV LETT, Vol 48, 1982 p 406; Yin, M.T., Cohen, M.L., PHYS REV, Vol B26, 1982 pp 3259, 5668.
3. Wallis, R.F., J VAC SCI TECHNOL, Vol A3 No 3, 1985 p 1422.
4. Baraff, G.A., et al., PHYS REV, Vol B21, 1980 p 5662.
5. Lee, O.H., Joannopoulos, J.O., PHYS REV LETT, Vol 48, 1982 p 1846.
6. Chadi, D.J., PHYS REV LETT, Vol 41, 1978 p 1062; PHYS REV, Vol B19, 1979 p 2074.
7. Weber, W., Varma, C.M., PHYS REV, Vol B19, 1979 p 6142.
8. Allan, D.C., Mebe, E.J., PHYS REV, Vol B31, 1985 p 5565; Mebe, E.J., et al., J VAC SCI TECHNOL, Vol B3 No 4, 1985 p 1058.
9. Harrison, W.A., "Electronic Structure and Properties of Solids," Freeman, San Francisco, 1980.
10. Sokel, R.C., BULL AM PHYS SOC, Vol 21, 1976 p 1315.

11. Lin Zijing, et al., SCIENCE BULLETIN, Vol 33, 1988 p 416.
12. Wendel, H., Martin, R.M., PHYS REV LETT, Vol 40, 1978 p 950; PHYS REV, Vol B19, 1979 p 5251.
13. Nilsson, G., Nelin, G., PHYS REV, Vol B3, 1972 p 364; Nelin, G., Nilsson, G., PHYS REV, Vol B5, 1972 p 3151.
14. Chadi, D.J., J VAC SCI TECHNOL, Vol 16, 1979 p 1290.
15. Allan, D.C., Mebe, E.J., in "Proceedings of the First International Conference on the Structure of Surfaces, Berkeley," edited by M.A. Van Hove, Springer, New York, 1984.
16. Tong, S.Y., Xu, G., Mei, W.N., PHYS REV LETT, Vol 52, 1984 p 1693.
17. Chadi, D.J., PHYS REV LETT, Vol 52, 1984 p 1911.
18. Lin Zijing, et al., JOURNAL OF THE UNIVERSITY OF SCIENCE AND TECHNOLOGY OF CHINA, (publication pending).
19. Fraukel, D.J., J VAC SCI TECHNOL, Vol B3 No 4, 1985 p 1093.
20. Ding Xunmin, et al., SEMICONDUCTOR JOURNAL, Vol 4, 1983 p 284.
21. Oshima, C., et al., SOLID STATE COMMUN, Vol 57, 1985 p 283; PHYS REV LETT, Vol 26, 1986 p 227; Oshima, C., PHYS REV, Vol B34, 1986 p 2949.
22. Kelly, M.K., et al., J VAC SCI TECHNOL, Vol A3 No 3, 1985 p 1481.

Degenerate Ground State Steepest Descent Perturbation Theory

[English abstract of article by Wen Genwang [2429 2704 2489] of the Department of Physics, Hunan Normal University, Changsha]

[Text] In this paper, an entirely new approach to quantum mechanics calculation, the non-degenerate ground state steepest descent perturbation theory (SDPT) suggested by Cioslowski, is developed and extended for dealing with degenerate ground state problems. Using symmetry-adapted trial waves, the SDPT iteration for each sublevel is independent from the others and improves its eigen energy and wave function step by step. Therefore, the steepest descent perturbation theory can be used to calculate the low symmetry splitting of the degenerate ground state and the correlation energy to an arbitrary level of precision. Unlike other perturbation theories, this does not require either infinite summation overstates or the solution to a set of differential equations. Therefore, it can be expected to be widely adaptable in the calculation of energy level perturbation splitting of atoms, molecules and other many body quantum systems.

References

1. Cioslowski, J., J CHEM PHYS, Vol 86, 1987 p 2105.
2. Cao Jinyan, "Quantum Physics," Vol 2, Science Press, Beijing, 1981.
3. Cai Jianhua, et al., "Green's Function Theory in Quantum Statistics," Science Press, Beijing, 1983 p 132.
4. Hirschfelder, J.O., Brown, W.B., Epstein, S.T., "Advances in Quantum Chemistry," edited by P.O. Löwdin, Academic, New York, 1964, Vol 1 p 256.
5. Xi Shaolin, et al., "Optimized Computation Methods," Shanghai Science Press, Shanghai, 1983 pp 61-74.
6. Elliott, J.P., Dawber, P.G., "Symmetry in Physics," Vol 1, 1986.
7. Wen Genwang, PHYS REV, submitted.

Warm Ion Effects on Kinetic Drift Cyclotron Loss Cone Instabilities

40090039d Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 37 No 12, Dec 88 pp 1993-2003

[English abstract of article by Guo Shichong [6753 0013 1404], et al., of the Institute of Physics, Chinese Academy of Sciences]

[Text] The effects of adding warm plasmas to the kinetic DCLC mode in high loss cone plasmas have been investigated in detail. It is found that when the fluid DCLC mode is stabilized by a small amount of warm plasma, the kinetic excitation remains due to two different mechanisms, namely, (1) magnetic drift resonance dissipation excites the negative energy wave; (2) a new type of positive energy wave can become unstable as the resonance condition is met. Compared with the fluid approximation theory, more warm plasmas are needed to suppress the kinetic DCLC instabilities.

References

1. Cohen, B.I., UCAR 10049-80-Rev 1, 1980 pp 2-91.
2. Coensgen, F.H., et al., PHYS REV LETT, Vol 35, 1975 p 1501.
3. Simonen, T.C., PHYS FLUIDS, Vol 19, 1976 p 1355.
4. Turner, W.C., et al., PHYS REV LETT, Vol 39, 1977 p 1087.
5. Berk, H.L., Gerver, M.J., PHYS FLUIDS, Vol 19, 1976 p 1646.
6. Baldwin, D.E., et al., PHYS REV LETT, Vol 36, 1976 p 1051.
7. Gerver, M.J., PHYS FLUIDS, Vol 21, 1978 p 443.
8. Gerver, M.J., PHYS FLUIDS, Vol 19, 1976 p 1581.
9. Ng, P.H., PHYS FLUIDS, Vol 22, 1979 p 1141.
10. Post, R.F., Rosenbluth, M.N., PHYS FLUIDS, Vol 9, 1966 p 730.
11. Baldwin, D.E., REV MOD PHYS, Vol 49, 1976 p 317.
12. Lindgren, N.E., et al., PHYS FLUIDS, Vol 19, 1976 p 1026.
13. Tang, W.M., et al., PHYS FLUIDS, Vol 15, 1972 p 1153.
14. Post, R.F., Lawrence Livermore National Laboratory Report, UCRL-70681, 1967.
15. Guo Shichong, et al., ACTA PHYSICA SINICA, Vol 36, 1987 p 1598.
16. Tsai, S.T., Guo, S.C., "Proceedings of Sino-Japan Bilateral Workshop on Statistical and Condensed Matter Theory," edited by Xie Xide, World Scientific Pub. Co., Singapore, 1986 p 240.
17. Baiborodov, Y.T., et al., "Proceedings of 6th Euro Conf Controlled Fusion Plasma Physics," Vol 2, USSR Academy of Sciences, Moscow, 1973 p 122.

Growth of Large Single Crystal of $LnBa_2Cu_3O_{7-\delta}$, Its Superconductivity

[English abstract of article by Sun Dunming [1327 2415 2494], et al., of the Department of Applied Chemistry, University of Science and Technology of China, Hefei; Niu Liwen [3662 4539 2429], et al., of the Center of Structural and Elemental Analysis, University of Science and Technology of China, Hefei; Xia Jiansheng [1115 0526 3932], et al., of the Department of Physics, University of Science and Technology of China, Hefei]

[Text] The growth of the large single crystal $LnBa_2Cu_3O_{7-\delta}$ and its super-conductivity is reported in this paper. Identification methods for single crystals, e.g., Laue pattern, precision pattern and the OOL multiple-order diffraction with X-rays, are discussed.

References

1. Wang, H.H., Geiser, U., Thorn, R.J., et al., INORG CHEM, Vol 26, 1987 p 1190.
2. Takei, H., Takeya, H., Iye, Y., et al., "Technical Report of ISSP Ser A," No 1827, 1987.
3. Ding, T.R., Worthington, T.K., Gallagher, W.J., et al., PHYS REV LETT, Vol 58, 1987 p 2687.
4. Qian Yitai, et al., SILICATE BULLETIN, (publication pending).

Thermal Expansion Coefficient of $YBa_2Cu_3O_{7-x}$ with Orthorhombic, Tetragonal Phases

[English abstract of article by Ruan Yaozhong [7086 5069 6988], et al., of the Department of Physics, University of Science and Technology of China, Hefei; Peng Dingkun [1756 1353 0981], et al., of the Department of Material Science, University of Science and Technology of China, Hefei]

[Text] The thermal expansion coefficient of $YBa_2Cu_3O_{7-x}$ with tetragonal and orthorhombic structural phases was measured by the differential parallel-plate capacitance method. Anomalies exist near 205 K in the orthorhombic phase and between 92 K and 130 K in the tetragonal phase, respectively, The authors suggest that the former may be related to the lattice instability, indicating that there is a strong electron-phonon interaction; the latter may result from the structural phase transition which destroys the high T_c superconductivity. A small jump in the thermal expansion coefficient at T_c was observed in the orthorhombic phase and, from this, the pressure effect was estimated.

References

1. Bednorz, J.G., Muller, K.A., Z PHYS, Vol B64, 1986 p 189.
2. Beyers, R., et al., submitted to APPL PHYS LETT.
3. Jorgensen, J.D., et al., PHYS REV LETT, Vol 58, 1987 p 1024.
4. Zhang Yuheng, et al., submitted to CHINESE PHYS LETT.
5. Ruan Huizhong, et al., ACTA PHYSICA SINICA, Vol 36, 1987 p 1219.
6. Du Jiaju, et al., "Proceedings of 1987 International High T_c Conference, Beijing," p 333.
7. Zhu Jingsheng, et al., submitted to SCIENCE BULLETIN.
8. He Yusheng, et al., "Proceedings of the 3rd All-China Symposium on Low Temperature Physical Properties," 1987.
9. Guan Weiyan, et al., "Superconductive Electrical Properties," Science Press, 1981.
10. Chen Zhaojia, et al., SOLID STATE COMMUN, Vol 64, 1987 p 685.
11. Hor, P.H., et al., PHYS REV LETT, Vol 58, 1987 p 911.
12. Douglass, D.N., "AIP Conf Proceedings," No 4, New York, 1972.

Crystal Structure, Superconductivity of $Bi_2Sr_2CaCu_2O_8$ Compound

[English abstract of article by Liang Jingkui [2733 2417 7608], et al., of the Institute of Physics, Chinese Academy of Sciences]

[Text] The crystal temperature of the ideal composition compound $Bi_2Sr_2CaCu_2O_8$ with zero resistance temperature $T_c(0)$ - 81.4 K has been determined by the X-ray powder diffraction method. The basic structure of this compound exhibits tetragonal symmetry with lattice constants a = 3.825 Å. c = 30.82 Å. The most probable space group is D_{4h}^{17}-14/mmm. Each unit cell contains two formula units. The arrangements of atoms in the unit cells are as follows:
2Ca cations occupy the 2(a) equivalent position;
4Sr, 4Bi and 4Cu cations occupy the same equivalent point position, 4(e) with respective parameters z = 0.110, 0.302, 0.445;
16O anions respectively occupy 8(g) (z = 0.445) and two 4(e) equivalent point positions (z = 0.210 and z = 0.380). The crystal structure of $Bi_2Sr_2CaCu_2O_8$ can be derived from the Aurivillius-type structure. The main feature of the structure is the alternate arrangement of cations along (00z) and (1/2, 1/2, z) of tetragonal system. The other possible superconducting phases in the Bi-Sr-Ca-Cu-O system can be thought of as having structures with different stacking layers along the z axis.

<div style="text-align:center">References</div>

1. Bednorz, J.G., Muller, K.A., Z PHYS, Vol B64, 1986 p 189.
2. Wu, M.K., et al., PHYS REV LETT, Vol 58, 1987 p 908.
3. Zhao, Z.X., et al., KEXUE TONGBAO, Vol 32, 1987 p 661.
4. Michel, C., et al., Z PHYS, Vol B68, 1987 p 421.
5. Maeda, H., et al., JPN J APPL PHYS, Vol 27, 1988 p L209.
6. Chu, C.W., et al., PHYS REV LETT, Vol 60, 1988 p 941.
7. Zhao, Z.X., et al., SUPERCONDUCTOR SCIENCE AND TECHNOLOGY, (in press).
8. Xie, S.S., et al., SOLID STATE COMMUNICATIONS, Vol 66, 1988 p 1211.
9. Zhang, Y.L., et al., SUPERCONDUCTOR SCIENCE AND TECHNOLOGY, Vol 1, 1988 p 92.

10. Liang, J.K., et al., PHYSICA STATUS SOLIDI (A)--APPLIED RESEARCH, Vol 109, 1988.
11. Liang, J.K., et al., J PHYS D--APPLIED PHYSICS, Vol 21, 1988 p 1031.
12. Aurivillius, B., ARKIV FUR KEMI, Vol 1, 1949 p 463; Vol 1, 1950 p 449; Vol 2, 1950 p 519; Vol 5, 1952 p 39.
13. Liang, J.K., et al., MODERN PHYSICS LETTERS B, Vol 2, 1988 p 673.

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